



Legal and institutional tools to mitigate plastic pollution affecting marine species: Argentina as a case study



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ABSTRACT

Plastics are the most common form of debris found along the Argentine coastline. The Río de la Plata estuarine area is a relevant case study to describe a situation where ample policy exists against a backdrop of plastics disposed by populated coastal areas, industries, and vessels; with resultant high impacts of plastic pollution on marine turtles and mammals. Policy and institutions are in place but the impact remains due to ineffective waste management, limited public education and awareness, and weaknesses in enforcement of regulations. This context is frequently repeated all over the world. We list possible interventions to increase the effectiveness of policy that require integrating efforts among governments, the private sector, non-governmental organizations and the inhabitants of coastal cities to reduce the amount of plastics reaching the Río de la Plata and protect threatened marine species. What has been identified for Argentina applies to the region and globally.

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1. Introduction

Plastics are among the most common and persistent pollutants in coastal and marine environments worldwide (Derraik, 2002; Moore, 2008). The sources of pollution are land and marine-based, their origins may be local or distant, and their environmental consequences include global hazards to shipping, fisheries and other maritime activities (Pruter, 1987). Particularly important are the deleterious effects on marine biodiversity (Laist, 1987). More than 200 species have been found to be impaired by plastics through entanglement or ingestion; a number that will likely increase as smaller organisms are assessed (Cole et al., 2011; Moore, 2008). This phenomenon is even more conspicuous in marine megafauna: lacerations, intestinal obstructions, nutrient dilution, and even death have been reported in 44% of species of seabirds, 32% of species of cetaceans, 58% of species pinnipeds and all seven sea turtle species (Fowler, 1987; Gregory, 2009; Laist, 1987; Moore, 2008; Schuyler et al., 2012, 2014).

Mitigation of impacts arising from plastic pollution includes a broad range of measures including structural controls, the promotion of economic incentives and the organization of educational campaigns, among others (Derraik, 2002; Moore, 2008). These measures decrease impacts on marine species, although their use and effectiveness have been seldom addressed (e.g. Liu et al., 2013; Moore et al., 2005). Instead, most studies have focused simply on the description and quantification of the plastics ingested by these species (e.g. Bugoni et al., 2001; Lazar and Gračan, 2011; McCauley and Bjørndal, 1999; Tomás et al., 2002). One of the potential mitigation interventions includes legal tools (McIlgorm et al., 2011), but complexities arise due to jurisdictional and legal constraints. For example, as a considerable proportion of plastic in the oceans emanates from land-based sources (Pruter, 1987), effective waste management on land seems to be critical to the protection of marine species. A major failing is that waste regulation on land is outside of the scope of marine legislation and management under which these species are usually protected. Polluters affecting marine species include sources and agents that are far from the ocean (Pruter, 1987). Coordination and organization between different jurisdictions and legal fields requires understanding of the impacts in those areas to which plastics disperse, with interventions to reduce pollution planned in the context of local policy and institutions.

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This paper uses Argentina – where plastics are the most common debris found along at least 2000 km of coastline (Colombini et al., 2008; Esteves et al., 1997) – as a case study for investigating this issue in more detail. More precisely, it focuses on the Río de la Plata, an estuarine system shared by Argentina and Uruguay, to analyze the problem of marine species impacted by plastic pollution in the context of current plastics use and effectiveness of local policy. The Río de la Plata is one of the largest (>38,000 km²), highly productive estuarine systems in South America, subject to a high degree of anthropogenic pressure (e.g. industries, fisheries, overpopulated coastline) that export plastics into the system (Fig. 1). The geographic area is also important because plastic pollution accumulates due to a quasi-permanent water front that develops downriver of the highly populated and industrialized cities (Acha et al., 2003; Mianzan et al., 2001), and marine species that reside or forage in the vicinity of this front are exposed to increasing levels of plastic pollution (Denuncio et al., 2011; Foro para la Conservación del Mar Patagónico y Áreas de Influencia, 2008; González Carman et al., 2014). The management of the area encompasses several jurisdictions – including international boundaries – with multiple regulatory processes and institutions that require improved coordination.

This work: (a) lists species affected by plastic pollution, (b) describes legal and institutional tools of Argentina relevant to this threat, and (c) identifies weaknesses in current policy and implementation that – *inter alia* – have contributed to the amplification of plastic pollution. We provide practical suggestions to mitigate this threat for local decision makers, and our approach and recommendations may be useful to other regions where plastic pollution is a growing concern.

2. Plastic pollution in the Río de la Plata

The Río de la Plata extends between Punta Gorda (33°54'58"S, 58°24'52"W) to the imaginary line linking Punta del Este (Uruguay)

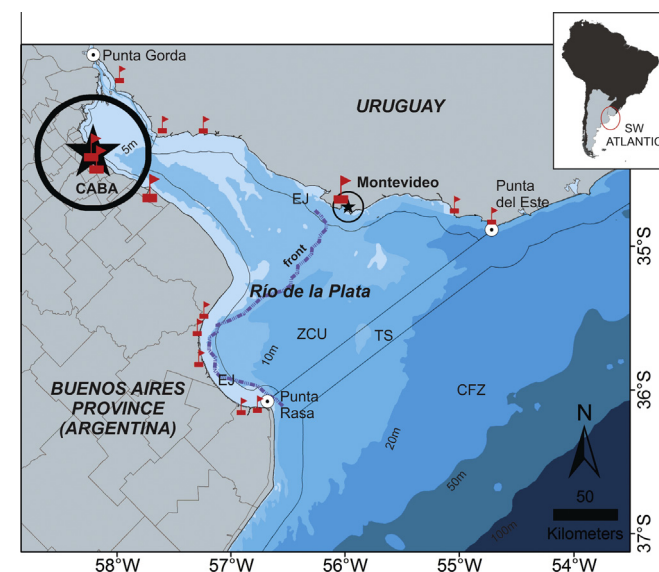


Fig. 1. Jurisdictions and locations within the Río de la Plata estuarine area. Gray dashed lines represent municipalities within Buenos Aires Province. Stars represent capital cities of Argentina and Uruguay and circles are proportional to population size. Red flags represent ports and size indicates relative importance. Modal position of the front is from Framiñan and Brown (1996). CFZ: common fishing zone between Argentina and Uruguay, ZCU: zone of common use, EJ: exclusive jurisdiction (2 or 7 nautical miles depending on the area), and TS: territorial sea (up to 12 nautical miles). Maps serve illustration purposes and are not meant to be authoritative. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

to Punta Rasa (Argentina) (Fig. 1). To the SW, it adjoins the Buenos Aires Province and the city of Buenos Aires (itself an autonomous district). To the NE, the Río de la Plata borders with Uruguay. Each country has exclusive jurisdiction over the coastal zone up to 2–7 nautical miles. There is also an adjacent common, bilaterally managed fishing zone (Fig. 1).

The Río de la Plata can be considered a relatively closed system where sources of plastic pollution can be identified and managed properly. Major input of plastics to the Río de la Plata may come from industrial and urban areas that lie along its coastline (Acha et al., 2003) (Fig. 1). The cities of Montevideo (Uruguay) and Buenos Aires and their suburban areas are inhabited by more than 18 million people (DPE, 2010; FREPLATA, 2007; INE, 2012), and Buenos Aires alone generated a record two million tons of waste in 2010 (FARN, 2012). Plastics constituted 13–17% of the waste generated (SAyDS, 2005, 2012; OPP, 2005). Waste management is limited to household collection, public cleansing, and landfilling (SAyDS, 2005; OPP, 2005). Landfills are filled beyond capacity which results in gas emissions and contamination of surface and subterranean waters through leachate leakage. Some landfills are located in areas prone to flooding (Banco Mundial, 1995; BID-OMS, 1997; FARN, 2014; SAyDS, 2005; OPP, 2005). In addition, hundreds of illegal open dumps exist in the Buenos Aires Province, especially in suburbs of Buenos Aires (Banco Mundial, 1995; FARN, 2012; SAyDS, 2005, 2012). Waste originated from these highly urbanized areas (including plastics) reaches the Río de la Plata via rivers, streams and municipal drainage systems. Additional sources are via beach pollution and wind that blows waste from landfills. Intense vessel traffic in the Río de la Plata and adjacent areas likely also increases the pollution load to the region (Acha et al., 2003). At least 14 ports exist in the study area, including the maritime access to the fluvial system named *Hidrovia*, which links rivers of the Amazon Basin (Acha et al., 2003; Mianzan et al., 2001). The basin and the Río de la Plata sustain industrial and artisanal fisheries involving more than 500 vessels and 2000 fishermen (Defeo et al., 2009; Mianzan et al., 2001). Plastics generated by cities, industries and vessel traffic accumulate in a frontal system that is the result of the confluence of riverine and estuarine waters (Acha et al., 2003) (Fig. 1). The result of this is that a proportion of the waste that reaches the river, mostly plastic bags, is not transported to distant areas but remains within the boundaries of the system.

3. Marine species affected by plastic pollution

Green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) sea turtles inhabit the Río de la Plata from November to May, and are known to ingest plastic (González Carman et al., 2011, 2012a, 2014). González Carman et al. (2014) demonstrated that turtles are exposed to high concentrations of plastics and ingest them frequently: more than 90% of studied turtles ($n = 62$) had plastics, mainly plastic bags, in their digestive tracts. Plastics were also recorded in the resident Franciscana dolphins (*Pontoporia blainvillei*) (Denuncio et al., 2011; Mendez et al., 2008), listed as Vulnerable on the IUCN Red List™ (IUCN, 2013). Denuncio et al. (2011) reported that 88% of the dolphins caught in nets ($n = 106$) had plastics in their stomachs, of which packaging debris (cellophane, plastic bags, and bands) were most common (64%). In both sea turtles and dolphins, the likely source of the ingested waste can be attributed to urban and industrial sources, as well as to vessel traffic.

4. Public policy information

Argentina enacts minimum standard laws that include regulations pertinent to the protection of the environment and waste

management (Sabsay et al., 2006). The provinces and Buenos Aires city must adhere to these laws. Being a federal country, the provinces and Buenos Aires own and have jurisdiction over natural resources (FARN, 2012; Sabsay et al., 2006). Relevant policy tools were then considered relative to each jurisdiction: international, regional, national, Buenos Aires Province and Autonomous City of Buenos Aires (CABA). A detailed description of the provisions found in each regulation is provided in the supplemental material (Table S1 and S2).

Sources of information related to plastic pollution and policy included the Digital Library of Treaties (<http://tratados.cancilleria.gob.ar>), InfoLEG – Legislative and documental information (Arg. Información legislativa y documental, <http://www.infoleg.gov.ar>), Secretariat of Environment and Sustainable Development (Arg. Secretaría de Ambiente y Desarrollo Sustentable de la Nación – SAYDS – <http://www.ambiente.gov.ar>), Government of Buenos Aires Province (Arg. Gobierno de la Provincia de Buenos Aires, <http://www.gba.gov.ar>), Legislature of CABA (Arg. Legislatura Porteña, <http://www.legislatura.gov.ar>), Provincial Organism for Sustainable Development (Arg. Organismo Provincial para el Desarrollo Sostenible – OPDS – <http://www.opds.gba.gov.ar>), Environmental Information System of MERCOSUR (Arg. Sistema de Información Ambiental del MERCOSUR, <http://www.mercosurambiental.net>), International Maritime Organization (IMO, <http://www.imo.org>), United Nations Environment Program (<http://www.unep.org>), and Argentine Coast Guard service (Arg. Prefectura Naval Argentina – PNA – <http://www.prefectura naval.gov.ar>). See Table 1 for a list of acronyms.

5. Legal and institutional framework pertinent to plastic pollution and the conservation of marine species

Argentina is formally committed to protect threatened species of marine turtles and mammals, and prevent, reduce and control pollution of the marine environment from any source, via a range of multilateral, bilateral, national, provincial and municipal policies. Under ideal conditions, the Río de la Plata estuarine area would be mostly free of plastics, because these policies direct that:

- Vessels cannot intentionally dispose plastics on the marine environment and ports should count with adequate facilities to dispose them.
- At cities, the amount of plastic sent to landfills should be minimal due to reduction, reutilization and recycling.

Table 1
List of acronyms.

Acronym	Name
CABA	Buenos Aires city
UNCLOS	United Nations Convention on the Law of the Sea
CBD	Convention on Biological Diversity
CMS	Convention on Migratory Species
IAC	Inter-American Convention for the Protection and Conservation of Sea Turtles
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships
IMO	International Maritime Organization
PNA	Argentine Coast Guard
TCMF	Technical Commission of the Maritime Front (Río de la Plata Bilateral Treaty)
MERCOSUR	Common Market of the South
EIA	Environmental Impact Assessment
SAYDS	Secretariat of Environment and Sustainable Development
COFEMA	Federal Environmental Council
IWM	Integrated Waste Management
OPDS	Provincial Organism for Sustainable Development
APRA	Environmental Protection Agency

- Open dumps are prohibited and landfills cannot be in areas prone to flooding.
- Waste management should have environmental impact assessments.
- At least in some markets, biodegradable bags should be used instead of reusable cloth bags.

This is sustained by the following policies:

5.1. International and regional policy

Commitments to protect marine species and its habitats from hazardous human activities were adopted through the UN Convention on the Law of the Seas (UNCLOS), the Convention on Biological Diversity (CBD), the Convention on Migratory Species (CMS), and the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) (Fig. 2 and Table S1).

Specifically pertinent to pollution is The London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. It promotes the effective control of land-based sources of marine pollution to prevent any deliberate dumping of wastes, including plastics and other persistent synthetic materials, such as nettings and ropes. Its introduction explicitly mentions the hazards of pollution to human health, natural resources and the marine life (Fig. 2 and Table S1).

Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78, a combination of the 1973 Convention and the 1978 Protocol) provides regulations for the prevention of pollution by garbage from ships, with garbage defined as all kinds of victual, domestic and operational waste generated during the normal operation of the ship and liable to be disposed. All garbage should be retained on board for disposal at adequate shore reception facilities. If it is not possible, the disposal into the sea should be made as far as practicable from the nearest land and, in no case, at a distance below the range stipulated by the Convention that depends on the geographic area. This is applicable to all marine vessels, including commercial and fishing vessels, as well as pleasure crafts. The Convention specifically mentions the disposal of plastics, including bags, ropes and fishing nets. Coastal States, such as Argentina and Uruguay, have an obligation to provide adequate reception facilities for waste at their ports (Fig. 2 and Table S1).

The London Convention and MARPOL are treaties promoted by the International Maritime Organization (IMO), a specialized agency of the United Nations responsible for improving the safety and security of international shipping, and for preventing marine pollution from ships. IMO's governing body is the Assembly integrated by its 170 Member States, including Argentina and Uruguay. The IMO, and its Marine Environment Protection Committee, attempt to guarantee that conventions on pollution and other treaties are adopted, regulated and properly implemented by the Parties. With this purpose, the Marine Environment Protection Committee enacts technical resolutions and recommendations to Member States.

In the context of the London Convention and Annex V of MARPOL 73/78, Argentina enacted laws (N° 21.947 and N° 24.089, respectively) that provide to the Coast Guard service (herein after called PNA by its Spanish abbreviation) police authority under the Ministry of Security. PNA acts through the Office of Environmental Protection to ensure the implementation of national legislation and commitments via international treaties to prevent pollution of the marine environment by hydrocarbons and any other harmful substances in fluvial, lacustrine and maritime waters. PNA enacts its own regulations as well as technical, administrative and operating procedures to implement control over pollution, such as the Regime for Navigation and several other ordinances. Some of these

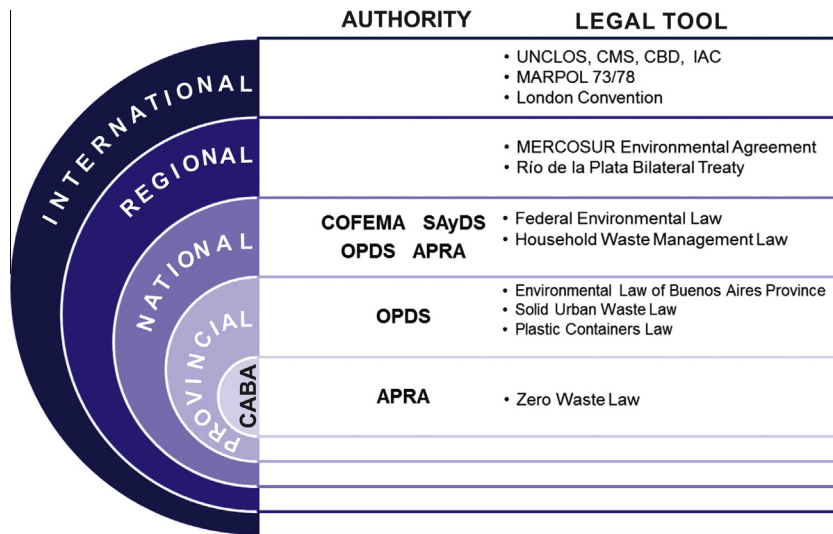


Fig. 2. Legal tools and agencies relevant to the prevention of plastic pollution and the conservation of marine species in Argentina.

adopt regulations of the London Convention and the Annex V of MARPOL 73/78 and adapt them to the local conditions in Argentina. For example, PNA ordinance N° 12/1998 prohibits the dumping of waste of any type and under any circumstances in areas of special protection such as the southwest coast of the Río de la Plata. Ships must retain waste in a safe manner in order to be disposed later in adequate port facilities guaranteed by port administrations. PNA ordinance N° 1/2014 prohibits the intentional dumping of waste, including plastics and other persistent materials, within national waters. PNA also has the power to draw up national and international certifications of pollution prevention, to inspect ships and to conduct environmental studies and monitoring programs. PNA cooperates directly with the IMO since it is responsible for enforcing the resolutions enacted by the Marine Environment Protection Committee.

Actions conducted by PNA at sea and ports have been mostly focused on the prevention of pollution from hydrocarbons rather than plastics despite the fact that provisions of the London Convention and the Annex V of MARPOL 73/78 explicitly include these (Table S1). Given the accumulation of plastics in the Río de la Plata, and their ingestion by dolphins and turtles (Acha et al., 2003; Denuncio et al., 2014; González Carman et al., 2014), it is fundamental that PNA enhances control on the deliberate dumping of plastics from vessels. The availability of adequate disposal facilities on land relies on port authorities, which varies depending on the port administration (national, provincial, municipal or private). Hence, cooperative work among PNA and port authorities is needed in Buenos Aires Province. A precedent exists for this: Until 2008 PNA participated in a project coordinated by the Secretariat of Environment and Sustainable Development (SAyDS) to prevent coastal pollution in Patagonia. A goal was to strengthen control on dumping of waste under MARPOL provisions in southern Patagonian ports. PNA was in charge of recording the amount and type of wastes generated by vessels and to design a waste management plan for ports, control its enforcement and charge fines in case of offenses. The same goals for the ports of Buenos Aires Province could help improve the disposal of plastics from vessels at adequate port facilities.

At the regional level, Argentina is signatory of two treaties pertinent to the protection of the environment from harmful human activities: the Río de la Plata Bilateral Treaty and the MERCOSUR Environmental Agreement (Fig. 2 and Table S1). The first one is shared with Uruguay, and the second includes Uruguay, Brazil, Paraguay, Venezuela and Bolivia. Under the Río de la Plata Bilateral

Treaty, Parties are to develop guidelines regarding the shared jurisdictions of the Río de la Plata to prevent pollution of the marine environment (Fig. 1). The dumping of hydrocarbons is prohibited. Special attention is also given to land-based pollution, with priority given to pollutants from municipal sewage, tannery and agricultural activities (FREPLATA, 2004). A bi-national authority – the Technical Commission of the Maritime Front (TCMF) – is in charge of regulating human activities to ensure sustainability and promote research to evaluate and preserve resources.

The MERCOSUR Environmental Agreement promotes the adoption of common policies in topics such as biodiversity, sustainable production and solid urban wastes that could help mitigate the plastic pollution of the Río de la Plata (Table S2). Within this framework, a project on sustainable production and consumption was incorporated into the Argentine legislation (decree N° 1289/10). Its main goal is to promote and coordinate initiatives among members to improve the environmental performance and efficiency of productive processes seeking to increase competition and reduce risks to human health and the environment. This includes economic and financial instruments to change unsustainable production and consumption habits. The SAyDS is in charge of coordinating implementation within Argentina. Projects related to biodiversity and waste management are not yet that advanced (SAyDS, 2012).

Even though the Río de la Plata Treaty and the MERCOSUR Environmental Agreement do not include specific regulations on plastics, they provide the framework for regulating management of solid urban wastes with a top-down approach in the region. Such approach would avoid dealing with multiple nations (as in the case of multilateral instruments) and reach a consensus on joint efforts between Argentina and Uruguay to reduce plastic pollution in the Río de la Plata.

5.2. National policy

The Argentina Constitution provides the general national framework to reduce plastic pollution. It establishes the right to live within a healthy environment suitable for human development. It also obligates remedial action to environmental damage and directs authorities to provide environmental information and education to the public.

Other national norms set the minimum standards for the conservation and management of natural resources and ecosystems. The Federal Environmental Law established the National policy relevant

to plastic pollution (Table S2). This tool provides the overarching environmental policy framework of Argentina, establishing principles such as precaution, prevention, sustainability and responsibility. Companies conducting dangerous activities that could cause current or future damage on the environment have administrative, civil and/or penal liability for the cost of preventive and corrective actions. Lack of information does not justify postponing conservation measures. The law provides for environmental impact assessments (EIAs) as a policy and management instrument to prevent environmental damage. Those planning to conduct potentially dangerous activities need an EIA previous to execution. EIAs must include the description of the activities to be conducted, the identification of their negative consequences and appropriate mitigation actions (Table S2). Therefore, environmental authorities at all levels (municipal, provincial and CABA) must require companies dealing with the management of solid urban waste to present an EIA prior to the construction and during operation of transfer and treatment plants as well as landfills. The SAyDS – the environmental management agency under the Chief Minister's Office – and the environment authorities of Buenos Aires Province and CABA are responsible for the enforcement of the Federal Environmental Law (Fig. 2).

Complementary to the Federal Environmental Law, Congress enacted the Household Waste Management Law that addresses waste materials produced during consumption processes and the development of human activities (Table S2). This includes waste of residential, urban, commercial, industrial and institutional sources not regulated by other norms focused in hazardous and/or industrial wastes. The Household Waste Management Law considers all steps in the waste stream: from household generation to final disposal; passing through the intermediate steps of initial disposal, collection, transfer, transport and treatment. This is called an integrated waste management (IWM) approach. Some of the main goals include to: ensure the protection of the environment and the quality of life, minimize the amount of domiciliary waste that reaches final disposal and recover value from waste through reutilization and recycling in all forms (chemically, physically, mechanic, biologically) (Table S2).

The SAyDS and the environment authorities of Buenos Aires Province and CABA are responsible for enforcing the Household Waste Management Law (Fig. 2). The SAyDS must promote engagement of local people to reduce, reuse and recycle waste materials and incentivize the commitment of commerce and production sectors in management. It also must establish additional norms needed to effectively comply with the law. Consensus on the environment policies enacted must be reached by the authorities within the Federal Environmental Council (COFEMA), a decentralized organism appointed to coordinate among and cooperate with jurisdictions to achieve the objectives of the law (Fig. 2 and Table S2). The COFEMA shall also enforce that EIAs are conducted in national, inter-jurisdictional and international initiatives.

The impact of plastic pollution on marine species is implicitly included in the Household Waste Management Law since it aims to minimize the negative impact of wastes on the environment. Local authorities (i.e. provincial, municipal and CABA) must establish special programs for the management of those wastes that could present a significant risk for human and animal health. Besides, they must establish the requirements to construct final disposal sites according to the type of waste, the technology used and its location. The construction of these sites must be endorsed by relevant EIAs. Specifically, sites for final disposal may not be located at areas prone to flooding (Table S2). If properly implemented and enforced by pertinent authorities, these minimum measures could reduce the amount of plastics that reach the Río de la Plata carried by rivers and streams from landfills and reduce the amount of plastics disposed through reutilization and recycling.

5.3. Policy of Buenos Aires Province

The main provincial piece of legislation pertinent to the protection of the environment is the Buenos Aires Constitution. It expresses the commitment of the Province to the conservation of natural resources within its territory and the control of any activity that is detrimental to the ecosystem. Buenos Aires Province must promote actions to avoid the pollution of the air, soil and water and ensure the protection of ecologically important areas, flora and fauna.

Buenos Aires Province passed the Environmental Law to avoid detrimental impacts of human activities on the environment (Table S2). This law has a specific section stating the responsibility of each municipal state for their domestic waste. It also states that management at the municipal level must achieve waste prevention, reutilization, recycling, source segregation, and the evaluation of the environmental impact previous to constructing final disposal sites. The Provincial Agency for Sustainable Development (OPDS) is the authority to enforce this environmental law (Fig. 2).

The Environmental Law of Buenos Aires Province is a framework for the Solid Urban Waste Law (Table S2). This law establishes that municipal states are responsible for elaborating IWM plans for solid urban waste aiming to gradually achieve segregation, reutilization, and recycling of wastes during initial disposal, and a reduction on waste sent to final disposal within a specific timetable. The OPDS is the authority to enforce this law. It must advise and aid (i.e. technically, legally, and/or financially) municipal states to develop their IWM plans according to the principles and objectives of the law. The OPDS must also promote awareness and educational campaigns and the incorporation of technologies and processes to reduce wastes suitable to the local and regional environmental conditions. Several resolutions of the OPDS regulate these laws. Most important are the guidelines to elaborate the IWM plans (Resolution OPDS N° 40/2011) and the creation of a registry of technologies for treatment and final disposal of solid urban waste that does not jeopardize the health of the population, workers and the environment (Resolution OPDS N° 1142/2002 and 367/2010).

The Solid Urban Waste Law does not explicitly mention the problem of plastic pollution on marine species, but it does contain valuable measures to reduce the amount of plastics that may harm sea turtles and mammals in the Río de la Plata. The law recognizes open dumps as an important source of pollution, and thus suggests municipal authorities eradicate them. A 30%-reduction on waste sent to landfills within the first five years is planned (Table S2). Problems arise, however, when these provisions are not properly implemented and enforced. The Solid Urban Waste Law was enacted in 2006, but not regulated until 2010. Regulation is still incomplete and no significant steps to forward the goals of the law have been taken since 2010 (FARN, 2012, 2014). There has been no reduction in waste sent to landfills. In most municipalities source segregation, reutilization and recycling is not being conducted and landfilling practices continue to be overfilled (FARN, 2012). The excess of waste is such that the construction of new landfills is being evaluated while separation and compost plants are starting to be constructed (FARN, 2013; SAyDS, 2012).

The Solid Urban Waste Law is complementary to a law that prohibits the use of polyethylene bags and any other common plastic material used to transport products or goods (Table S2). According to the Plastic Containers Law, these materials must be replaced by containers made of degradable and/or biodegradable materials compatible with the minimization of the environmental impact. This measure reaches all supermarkets, supermarkets and mini-markets within Buenos Aires Province and the OPDS is the authority to enforce this law. The OPDS created a registry of manufacturers, distributors and importers of degradable and/or

biodegradable bags, whose products must be clearly identified with a logo (Resolution OPDS N° 134/2011). Today, only some markets sell both reusable cloth and biodegradable bags at the check-out and few municipalities have shown improvements in the implementation of this law. Besides, people using reusable cloth bags are few. Most of them buy degradable and biodegradable bags, which potential to reduce plastic pollution is debatable. Wellfair (2008) found that all degradable, biodegradable and non-degradable plastic bags were capable of some degradation after nine months of exposure in different simulated aquatic environments (e.g. muddy, sandy, freshwater, marine, with light, darkness, etc.), with some environments more prone to facilitate breakdown of the materials. Once ingested, however, degradation becomes slower. Müller et al. (2012) tested the decay characteristics of common shopping bag polymers by sea turtle gastrointestinal fluids. The differences between the degradation rates of standard and biodegradable bags were negligible, with biodegradable bags showing a degradation rate slower than reported by manufacturers. Therefore, the degradation of plastic bags in the animal's intestinal tracts is likely not rapid enough to prevent morbidity (Müller et al., 2012).

5.4. Policy of Buenos Aires city (CABA)

CABA enacts the Zero Waste Law for the management of solid urban waste, which implies measures to gradually achieve – with concrete dates and goals – a reduction in the final disposal of solid urban waste through waste prevention, source segregation and recycling (Table S2). The law is also contemplating extending responsibility to the private sector so that manufacturers, importers and distributors contributing products to the market that posteriorly turn into waste must contribute to the cost of recycling or disposal. It prioritizes waste prevention and the use of biodegradable and recycled materials. The Environmental Protection Agency (APRA), under the Ministry of Environment and Public Domain, is the authority to enforce this law (Fig. 2).

The Zero Waste Law contains measures that could reduce the amount of plastics that reach the Río de la Plata in the short term. For example, the law prohibits open dumps and the disposal of waste into water streams. The use of biodegradable bags to dispose of organic or wet waste is mandatory. The disposal of recyclable and reusable materials in landfills is to be prohibited by the end of 2020 (Table S2). But problems arise regarding the implementation of this law. The law was enacted in 2005, yet many important components are not regulated, such as those related to the use of biodegradable and recycled materials, the agreements needed to manage waste regionally and the programs to implement the private sector responsibility. In contravention of the goals, CABA has actually increased the amount of waste sent to landfills of Buenos Aires Province since 2006 (FARN, 2012). Only a reduction of land-filling was reported in 2013, after the construction of a treatment plant that aims to recover plastics as well as glass, paper and metal for reutilization and recycling. However, efforts to separate materials in this plant will be marginal if source segregation is not enhanced (FARN, 2014). Ten years after the law was enacted, source segregation is only now starting to be tested only in two neighborhoods within CABA.

6. Discussion and conclusions

The impact of plastics on marine species – particularly of waste generated in urban areas and vessel traffic – has recently been documented in the Río de la Plata (Denuncio et al., 2011; González Carman et al., 2014). This is despite a policy and institutional framework to advance conservation solutions which address this

threat across all jurisdictions. Through several international instruments, Argentina is committed to the protection of the marine environment, the fauna and the prevention of pollution (e.g. UNCLOS, CBD), particularly plastic pollution (e.g. Annex V of MARPOL 73/78, London Convention). The preservation of the marine ecosystem from pollution is also embedded in regional instruments such as the Río de la Plata Bilateral Treaty and the MERCOSUR Environmental Agreement. National norms set the minimum standards for the conservation of natural resources and ecosystems (i.e. Federal Environmental Law) and for solid urban waste management (i.e. Household Management Waste Law). Buenos Aires Province and CABA also have enacted legislation (i.e. Solid Urban Waste Law, Zero Waste Law) that should reduce waste reaching marine areas. Even though the hazard of plastic pollution to biodiversity is not mentioned explicitly, these laws promote waste management practices needed to regulate the entrance of plastics into the Río de la Plata. Implementing and enforcement agencies for these legal tools also exist (Fig. 2).

The most notable issues that turn plastic pollution a permanent threat to threatened marine species are inefficient waste management at urban areas and ports, delayed implementation periods for existing regulations, insufficient coordination among governmental agencies across jurisdictions, and lack of public participation:

- *Management of waste is deficient.* Open dumps still exist despite prohibition and many of them are located near water streams and the Río de la Plata. Current waste management continues focusing on landfilling in opposition to source segregation, reutilization and recycling (SAyDS, 2012). Particularly important is the regulation of specific procedures to achieve source segregation and recycling.
- *Dilated implementation times.* Critical measures, such as source segregation, reutilization, recycle and waste prevention, are not fully implemented. Plastics already at sea are likely to persist for long time, therefore efforts to minimize disposition, maximize reutilization and recycling and completely avoid the pollution of surface waters with plastics must urgently be in place.
- *Insufficient coordination.* Enhanced cooperation and coordination among agencies across jurisdictions could considerably improve implementation and enforcement of current regulations, specially to accomplish auspicious provisions (e.g. a 30% reduction on waste sent to final disposal within five years or the prohibition of the landfilling of recyclable and reusable materials by 2020) that otherwise turn into unrealistic goals. Particularly important are the coordination and communication between agencies of waste management and wildlife to reduce the impact of plastic pollution on threatened marine species; as well as between PNA and the port authorities to ensure the correct disposal of plastics from vessels.
- *Lack of public participation:* economic incentives and regulations to enhance participation in waste management of the industry and commercial sectors, as well as the general public, are almost nonexistent. Specific regulations on the extended responsibility of producers, importers and distributors of plastics containers could ensure a sustainable disposal of their products, especially plastic bags. Public commitment to reduce the amount of polyethylene bags used, as well as reutilize and recycle plastic products could help reduce the amount of plastic ending up in landfills or open dumps; and eventually reduce plastic pollution of the Río de la Plata and any other superficial waters.

6.1. Solutions inspired in other geographic areas

In Taiwan, policies on compulsory source segregation and restriction of plastic shopping bags and tableware improved solid

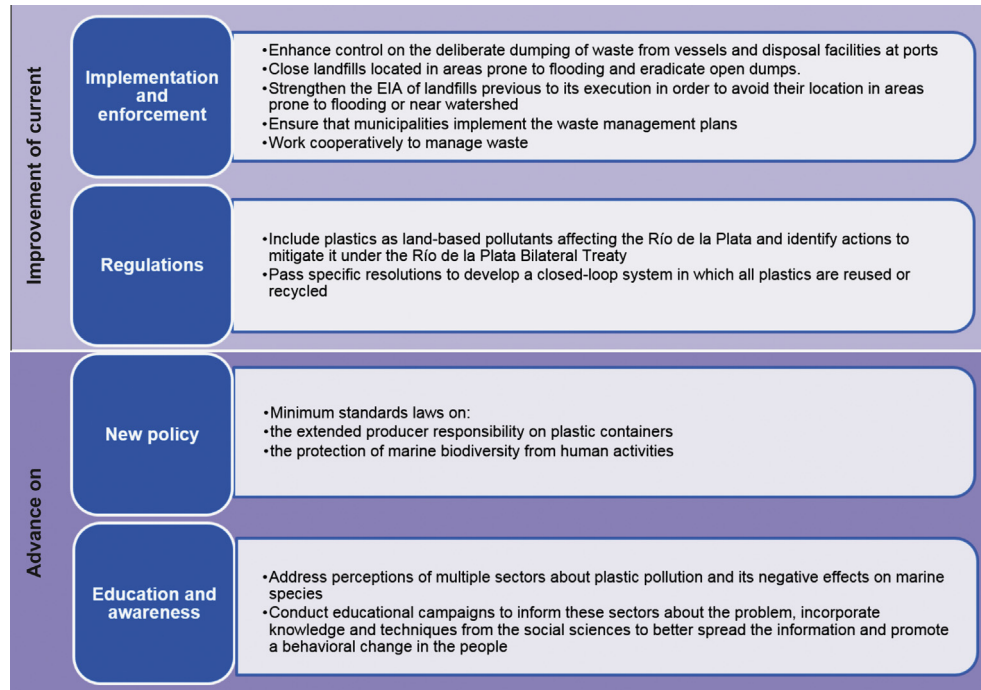


Fig. 3. List of practical suggestions to reduce plastic pollution affecting marine turtles and mammals in the Río de la Plata.

waste management to the point that it changed the composition of waste found at beaches. The percentage of plastic bags found at beaches decreased likely due to implementation of these policies (Liu et al., 2013). In the United States, the Environmental Protection Agency is devising a transition from waste management to sustainable materials management. This means seeking to use materials in the most productive way with an emphasis on using less, and reducing toxic chemicals and environmental impacts throughout the material's life cycle (EPA, 2012). In the European Union, the amount of recyclables in the market has increased 15% between 2004 and 2009. Partially, this is a result of obligations to recycle or recover increasing percentages of waste, and to regulations discouraging landfilling driven by the EU Waste Directives (European Commission, 2010; Newman et al., 2013). For example, the European Union enacted the Landfill Directive establishing technical requirements for the operation of landfills with the aim of reducing their impact on the environment including the pollution of surface water and to limit landfilling of waste. According to this Directive, landfill location must consider the proximity of water bodies and coastal waters, and landfill design must aim to avoid pollution of soil and waters from the landfill, including from wind-blown waste. This regulation has a high potential impact to prevent plastics pollution if properly implemented, since less waste sent to landfill may result in less waste reaching the marine environment (as it tends to mean more reutilization and recycling). The European Union also enacted the Packaging and Packaging Waste Directive that in part seeks to limit the amount of packaging waste going to final disposal by prioritizing prevention. Relevant measures include targets to increase reutilization and collection, requirements for packaging to facilitate recycling, among others. These have a high potential impact to reduce the amount of packaging waste in the marine environment, and also to reduce its harmfulness (Newman et al., 2013).

A particularly important policy on waste management is currently enforced in Uruguay. The Non-reusable Containers Law states that containers made of any material must enact a plan to dispose containers already used and any waste derived from them.

This plan shall comply with the goals of waste reduction, reutilization and recycling approved by the environmental authority of Uruguay. Otherwise, their use on the market is not legal. This law targets producers, vendors, importers and distributors working with non-reusable containers (Law N° 17.849). In this manner, Uruguay is starting to regulate the extended producer responsibility directly. In Argentina, this could easily be implemented particularly with plastic containers with a strong collaboration and commitment of the plastic industry sector.

6.2. Practical suggestions

Given the above gaps in the implementation of current policy and experiences from other countries, there is opportunity for refinements and improvements. Some urgent practical actions can be implemented based on the present situation and scientific knowledge (Fig. 3):

- Interventions supported by the current legal and institutional systems:

Improvement of implementation and enforcement:

- Enhance control on the deliberate dumping of waste, mainly plastics, from vessels and ensure the availability of adequate facilities to dispose plastics at ports of Buenos Aires Province. These efforts could be replicated in Uruguay in the context of the Río de la Plata Bilateral Treaty.
- Close current landfills located in areas prone to flooding and eradicate open dumps definitively in Buenos Aires Province.
- Strengthen the EIA of transfer and treatment plants and landfills previous to its execution in Buenos Aires Province in order to avoid the location of new landfills near watersheds or in areas prone to flooding.
- Ensure that municipalities implement the waste management plans stated in the Household Waste Management Law with schemes to reuse, recycle and reduce disposal of

their waste. Require municipal states to improve the information given on the amount of waste generated, disposed, reused and recycled to assess degree of success and enforcement of current regulations.

Work cooperatively among municipalities to manage waste within Buenos Aires Province and CABA.

Improvement of current regulations:

- In the frame of the Río de la Plata Bilateral Treaty, include plastics as land-based pollutants affecting the estuarine system and identify actions to mitigate it.
 - Pass specific resolutions to develop a closed-loop system in which all plastics are reused or recycled in the frame of the Household Waste Management Law. This includes specific regulations on source segregation and the use of recycled materials. This should be done by the SAYDS, OPDS and APRA within the COFEMA, and with the support of the MERCOSUR project on sustainable production and consumption.
- b. Actions that require new policy:
- Following the example of Uruguay, pass a law setting the minimum standards for the production, distribution, importation and use of plastic containers. Companies contributing plastic containers to the market should act according to the principles of the extended producer responsibility.
 - Pass a law establishing the minimum standards for the protection of marine biodiversity from human activities. Along with plastic pollution, populations of sea turtles and dolphins also undergo mortality from bycatch in fisheries of the Río de la Plata (Bordino et al., 2002; González Carman et al., 2011, 2012b).
- c. Actions to raise public awareness on the negative effects of plastic pollution on marine species:
- Conduct programs to address perceptions of multiple sectors (industrial, commercial, governmental and the general public) about plastic pollution and its negative effects on marine species.
 - Conduct educational campaigns (e.g. beach cleanups, mass media advertisements, etc.) to inform these sectors about the problem. In these campaigns, incorporate knowledge and techniques from the social sciences to better spread the information and promote a behavioral change in the people.

This paper presents 10 potential actions to decrease plastic pollution in the Río de la Plata that could have positive consequences to threatened marine species. The implementation of the proposed interventions would require commitment from the governments, but also from the private sector and the people that live along the coast or that indirectly affect the target site. Policies are ineffective outside of the proper societal values. Future research efforts should focus on setting current baselines of plastic pollution in the Río de la Plata to identify changes in plastic composition and load associated with improvements on implementation and enforcement of current legislation. The development of recycling technologies, biodegradable materials, cleaning and restoration of water systems should also be addressed.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.marpolbul.2014.12.047>. These data include Google maps of the most important areas described in this article.

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