

Ilija Vukadin

Institute of Oceanography and Fisheries (IOF)- Split,
Croatia Šetalište I. Meštrovića 63, 21000 Split, Croatia
e-mail: vukadin@izor.hr

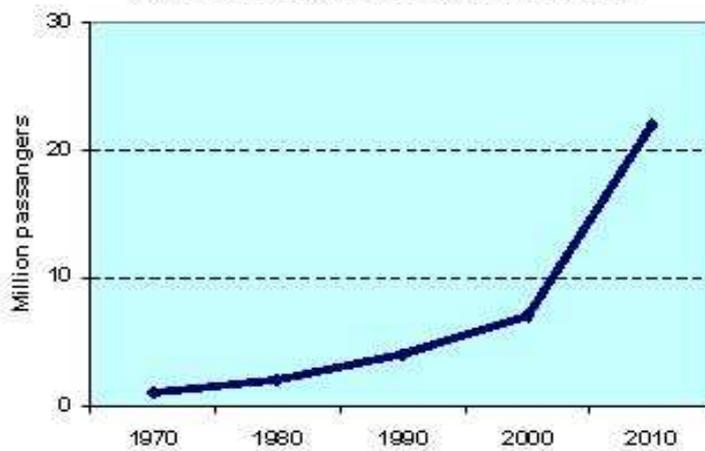
Protect our seas from cruise pollution

Introduction

Cruise ship tourism has experienced massive growth in the last thirty years, Figure 1. During these three decades, the number of people decide to spend their vacation on board one of these vessels has multiplied by 25 and so, as a result, have any associated problems. More than 50 companies control almost 300 cruise ships carrying more than 10 million passengers to ports around the globe each year. Some of the most popular tourist destinations are those which, at the same time, are the most sensitive to environmental disturbance. The Caribbean, Alaska, the Mediterranean, the Adriatic coasts of many small islands are subjected to visits from these giant vessels. Their natural beauty is the attraction, as these spots are very vulnerable. Big cruise liners can carry up to 3 000 people, including a crew of more than 1 000, which makes them true floating cities. With lengths that exceed 300 metres and gross tonnage of more than 100 000 GRT, onboard facilities include swimming pools, theatres, cinemas, restaurants, shops, saunas, tennis courts, photo processing shops, laundries, dry cleaning and everything a passenger could possibly require during his stay in his floating hotel. But all these activities generate hundreds of tons of waste of every kind, part of which is thrown into the seas and oceans plied by these ships.



Figure 1. Growth of the cruise ship industry



Cruise Ship Waste-Law and Regulation

The Clean Cruise Ships Act (IMO 2004) would bring cruise ships waste treatment practices in line with 21st century technology. Most important, the Act would help to preserve and protect the vibrant yet fragile ocean ecosystem which we all enjoy. This document would:

- Prohibit discharges of untreated sewage, graywater and oily bilge water within 12 miles of coast.
- Establish improved standards for levels of fecal coliform, total suspended solids (TSS) and chlorine in treated sewage and graywater, with the goal of zero pollution discharge by 2015.
- The cruise ships to have an oily water separator on board, but cruise lines have routinely illegally bypassed the separators to discharge higher concentrations of oil.
- Ensure illegal discharges by require better inspection and monitoring.

Following is a look at the types of waste that cruise ships produce and the applicable worlds laws and regulations.

Solid Waste

A cruise ship with 3 000 passengers and crew produces seven tons of garbage and solid waste every day.

The magnitude of the solid waste problem is staggering-about one billion kg of trash is dumped into world's oceans each year. The cruise ships are barred from dumping plastics anywhere at sea and floatable garbage within 25 miles of shore. They are permitted, however, to dump garbage that has been ground into pieces larger than one inch when they are three miles from shore, and ungrounded garbage when they are at least 12 miles from shore.

Air Pollution

A cruise ship with 3 000 passengers and crew generates air pollutants equivalent to 12 000 automobiles.

Cruise ships and other large marine vessels have diesel engines that are major sources of air pollution. One

cruise ship discharges 1.5 tons of smog-forming nitrogen oxides (the equivalent of 12,000 automobiles), 1.3 tons of sulphur oxides (the equivalent of a large cement plant), 95 kg of carbon dioxide, 37 kg of volatile organic compounds, and 28 kg of particulate matter, which is especially hazardous to persons with asthma and respiratory illnesses.

Gray water (water from laundries, sinks, kitchens, and showers):

A typical cruise ship with 3 000 passengers and crew generates from 400 to 1150 tons per day of graywater.

Grey water consist of non-sewage wastewater, including drainage from dishwashers showers, laundry, baths, galleys and washbasins. **Cruise ships are needlessly dumping vast amounts of raw sewage and other harmful wastes into some of the most pristine parts of our oceans every day.**

Each day a cruise ship generates as much as: 135 000 dm³ of sewage, 1 150 000 dm³ of dirty water from shower, sinks, laundries and dishwashers, as well as hazardous chemicals from photo processing, dry cleaning and industrial cleaning products; 32 000 dm³ of oily bilge water.

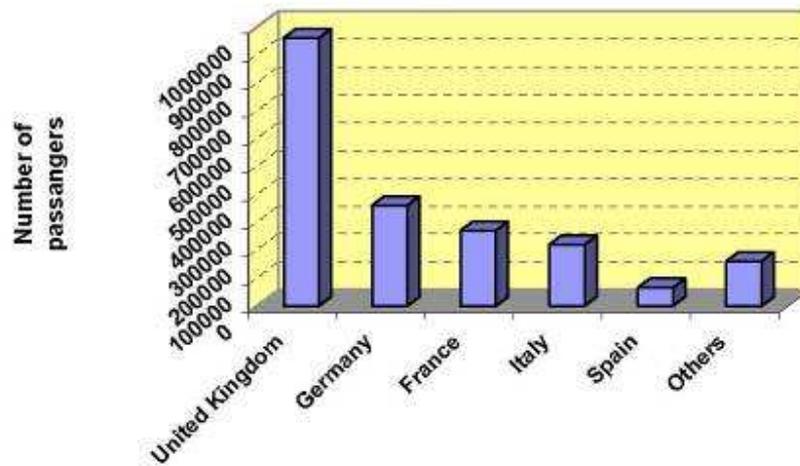
Oil Pollution

A cruise ship with 3 000 passengers and crew generates 30 000 dm³ of oily bilge water every day. Cruise ships, like nearly all vessels, generate oil, or petroleum hydrocarbon, pollution. Oil and oily waste discharges can result from collision, groundings, fuelling operation spills, and bilge pumping. On a ship, oil often leaks from engine and machinery spaces or from fittings and engine maintenance activities and mixes with water in the bilge, the lowest part of the hull of the ship.

Toxic waste

A cruise ship with 3 000 passengers and crew generates 40 dm³ of toxic chemicals every day. Toxic chemicals generated by cruise ships are generally waste products from photo developing, dry cleaning, painting and other activities. According to both International Council of Cruise Lines (ICCL) and International Maritime Organization (IMO) definitions, hazardous waste from cruise ships includes: waste from photo processing, including x-ray development fluid; dry-cleaning waste fluids and contaminated materials; print shop waste fluids; fluorescent and mercury vapour lamp bulbs and certain batteries.

Figure 2. Number of two million European cruise ship passengers (the majority of which were British, with 45%)



Ballast Water

A cruise ship with 3 000 passengers and crew generates hundreds of thousands of tons of ballast water, which contains diseases, bacteria and invasive species from foreign ports.

Cruise ships and other large vessels such as tankers and bulk cargo carriers use a tremendous amount of ballast water to stabilize the vessel. It is thought that a typical cruise ship could dump some 70 tons of ballast water per day, with the subsequent risk of introducing invasive dinoflagellate species into ecosystems and giving rise to red tides and pathogens. These can produce dangerous neurotoxins that cause massive fish kills and accumulate in shellfish illness and sometimes death in people who consume them.

Illegal Discharges Illegal environmental behavior is pervasive throughout the cruise industry. From 1993 to 2003, cruise ships committed more than 300 acts of dumping oil, garbage, hazardous waste, sewage and graywater, inflicting damage to coral reefs, and falsifying environmental records, paying more than \$50 million in fines and penalties. Worse, the illegal violations have continued even after multimillion dollar fines were levied against the largest cruise lines.

Dilution Zone

The dilution zone is comprised of a volume of water in which homogeneous mixing occurs upon introduction of a substance, such as graywater. The dilution zone, much like an initial mixing zone, is defined as a column of water bounded on the surface by the locus of points a constant distance from the point of discharge. The depth of the dilution zone is defined as the depth of the waterbody to the “ocean floor” or 20 m, whichever is shallower. A dimension of 30 m was used in the analysis of cruise ship graywater dispersion because it approximates the initial mixing zone requirements. The mixing inside the dilution zone is defined to occur over a four-hour period.

| | |
|----------------------|---|
| Dilution Zone Radius | = $R_{dz} = 30\text{m}$ |
| Dilution Zone Depth | = $D_{dz} = 20\text{m}$ |
| Dilution Zone Volume | = $\pi \cdot (R_{dz})^2 \cdot D_{dz}$ |
| | = $\pi \cdot (30\text{m})^2 \cdot 20\text{m}$ |
| | = $56,547 \text{ m}^3$ |

Graywater discharged from the typical cruise ship is diluted by a very large volume of receiving water. Under stationary ship conditions, a dilution factor* of 1.4×10^{-2} is calculated. Under transit conditions at a ship speed of 4 knots, the dilution factor is 2.2×10^{-5} (44 400-times dilution). At a ship speed of 6 knots, the dilution factor is: 1.5×10^{-5} (66 700-times dilution) and at a ship speed of 10 knots, the dilution factor is 8.9×10^{-6} (111 000-times dilution). These in-transit dilution factors represent approximately 630- to 1570-times greater dilution than under stationary ship conditions. Furthermore, the wake, tidal, and current actions that are normally present during discharge conditions provide many orders of magnitude more dispersion of the discharge constituents



Conclusion

Pollution from cruise ships is a growing problem. Cruise ships generate an astonishing amount of pollution, up to 110 tons of sewage from toilets and 630 tons of sewage from sinks, galleys and showers each day. Currently, not strictly anti-pollution laws allow cruise ships to dump untreated and inadequately treated sewage from toilets in state waters. This puts our coastal environment at risk from the threats of bacteria, pathogens and heavy metals generated in these waste streams.

References:

CLIA (2001). Cruise Line International Destination Analysis. OCEANA.
<http://www.stopcruise pollution.com> IMO Guidelines can be found at <http://globallast.imo.org> Cruise server Web site <http://www.cruiseserver.net> Marine Pollution-Progress made to reduce marine pollution by cruise ship, but important issues remain, <http://www.gao.gov/new.items> (January 2003) Cruise Control:

A report on How Cruise Ships Affect the Marine Environment. Washington DC: The Ocean Conservancy, May 2002.

*In a dilution, the dilution factor is equal to the final volume divided by the initial volume of solution, or

$$DF = V_f \div V_i.$$

Table 1. Type of waste generated by cruise ships

| Waste | Origin | Contaminants |
|----------------------|--|--|
| Greywater | Showers, washbasins, swimming pools, washing machines, etc. | Phosphates and other nutrients from soap and detergents: chlorine or fluoride from swimming pools and toothpaste: pathogen bacteria and any other potentially damaging substance used in personal hygiene. |
| Black water | Toilets | Faecal waters, bacteria, pathogens, organic waste, paper and any product flushed down the toilets. |
| Bilge water | The motors and turbines that propel the ship and supply energy for other onboard services. | Used oils, various hydrocarbons, etc. |
| Toxic waste | Photographic processes dry cleaning, paint, pharmaceutical products, dyes, electronic material, etc. | Can contain substances as toxic TBT (tributyl tin, a paint additive to stop algae formation), PCP (perchloroethylene for dry cleaning), heavy metals from paints and dyes, chemical compounds from drugs, acids and heavy metals from photographic material, light bulbs, fluorescents, batteries, toluene, xylene, benzene, organochlorates in solvents, etc. |
| Garbage | Food and the daily consumption of all kinds of products | Oil and chlorinated plastics, solid and organic residues, etc. |
| Air pollution | Diesel engines, sulphur in fuel, and other emissions from ships. | Cruise ship discharges smog-forming nitrogen oxides, sulphur oxides (the equivalent of a large cement plant), carbon dioxide, volatile organic compounds, particulate matter, which is especially hazardous to persons with asthma and respiratory illnesses. |
| Ballast water | Discharges of invasive species, toxic algal bloom. | Ballast water transports at least 7 000 different marine species each day around the world. Non-native species of plants, animals, pathogens and bacteria, threatening and at times destroying native species. |