Great Pacific Garbage Patch

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Great Pacific Garbage Patch Proposal

Sometimes referred to as the 8th Continent, a floating "island" of garbage, mostly made up of various plastic waste materials, the Great Pacific Garbage Patch, or GPGP, presents a unique problem to be fixed. It is also known as the Pacific Trash Vortex, and it spans ocean waters from Japan to the West Coast of North America.

Even though oceanographers and climatologists had predicted the existence of the Great Pacific Garbage Patch, it was Charles Moore, a racing boat captain who actually discovered the Trash Vortex in 1997. But it wasn't well known until a 16-year-old Dutch boy named Boyan Slat first envisioned the idea while SCUBA diving in Greece. He began to research various concepts and techniques for gathering plastics from ocean waters. At age 18, he gave a presentation at a TEDx Conference about his ideas, and in only a few months, the video of his presentation went viral. With a small amount of money, he was able to put together a team of volunteers and begin a crowdfunding campaign. This is when The Ocean Cleanup began. With 120 employees covering 30 countries, The Ocean Cleanup works to rid the planets most polluted oceans and rivers.

The GPGP covers a total area of 1.6 million square kilometers (twice the size of Texas) and contains 79,000 metric tons (2204.62 lbs/metric ton = 174,164,980 lbs, or **87,081 tons**) of plastic. Estimates are for the Ocean Cleanup project to collect and bring bring to shore nearly 10,000 metric tons (**11,000 tons**) to shore.

That's where we come in. Each *Thermo*MAX6™ Thermal Vortex System could process 1,608 tons per year, requiring 7 full units, either as a standalone system made up of a *Thermo*MAX6™ unit, shredder, hopper, and a conveyor or a complete energy recovery system which would include a waste heat boiler and a steam turbine generator set.

According to recent estimates, around 150 million metric tons (165 million tons) of plastic are currently in all the oceans globally, with about 8 million metric tons (9 million tons) added annually.

Our portion of the overall process would be to take the captured plastic once it comes to shore, and quickly process it in our *Thermo*MAX™ systems either as a standalone, or as part of an overall waste-to-energy (WtE) process. According to various articles, the plastics become degraded while being in the salt water of the oceans. This makes current recycling techniques much more difficult and more costly. Our technology can process any type of plastic in any condition.

For more information about The Ocean Cleanup, please visit:

https://theoceancleanup.com/

Boyan Slat and The Ocean Cleanup

Boyan Slat (27 July 1994) is a Dutch inventor and entrepreneur, passionate about creating megaprojects to address planetary problems. He is the founder and CEO of The Ocean Cleanup; a non-profit organization developing and scaling technologies to rid the world's oceans of plastic. The organization aims to put itself out of business, with the goal of removing 90% of floating ocean plastic by 2040.

STUDIED AEROSPACE ENGINEERING, BECOMES A CLEANER

While on vacation in Greece at ***16 years old***, Boyan was SCUBA diving and saw more plastic bags than fish in the sea, which left him thinking "Why can't we just clean this up?".

He started looking into the problem and possible technology solutions to clean up ocean plastic pollution, dedicating a school project to developing his idea further. *At only 18 years old, he presented his ideas at a TEDx Conference in late 2012. In February 2013, the TEDx video suddenly went viral, and the momentum that followed allowed Boyan to drop out of his Aerospace Engineering degree to officially found The Ocean Cleanup.*

10/20/2021:
Boyan Slat sharing a few words during the Proof of Technology announcement for System 002, The Ocean Cleanup's ocean system.

Armed with only €300 of saved-up pocket money, Boyan dropped out of his Aerospace Engineering degree at Delft University of Technology and started detailing his plan, but initially struggled to make progress. However, this all changed a few months later when Boyan's TEDx presentation was picked up and publicized by various news blogs – pushing the video around the world and causing the idea to go viral. This momentum allowed Boyan to assemble an initial team of volunteers and launch a crowdfunding campaign that funded a year-long feasibility study – the first real step in bringing Boyan's technological solutions to life. This is how The Ocean Cleanup started.

In the following years, Boyan led the organization through the initial scientific work, testing and concept iterations leading to successfully achieving Proof of Technology in 2021 for both river interception and cleanup of the Great Pacific Garbage Patch. Today, The Ocean Cleanup is actively cleaning up the Great Pacific Garbage Patch and has deployed Interceptors in some of the world's most polluting rivers to prevent plastic reaching the ocean in the first place. To see our progress, visit the Impact Dashboard.

> "When people say something is impossible, the sheer absoluteness of that statement should be a motivation to investigate further."
>
> — Boyan Slat

The Ocean Cleanup's headquarters are in Rotterdam, the Netherlands, with over 120 employees from more than 30 countries. In the role of CEO, Boyan focuses on strategy and relationships with key partners as well as serving as a figurehead for our crew, but continues to be deeply involved in the organization's scientific and technological work, through which he has co-authored around a dozen scientific papers and multiple patents.

Great Pacific Garbage Patch

The **Great Pacific Garbage Patch (GPGP)** is the largest accumulation of ocean plastic in the world, located between Hawaii and California. It primarily consists of tiny plastic particles, commonly referred to as **microplastics**, mixed with larger debris like fishing nets, bottles, and other floating waste. Here's a breakdown of its composition and cleanup efforts:

Composition of the Great Pacific Garbage Patch:

1. **Plastic Types:**
    - **Microplastics (smaller than 5 mm):** These make up the majority of the debris, coming from the breakdown of larger items over time.
    - **Macroplastics:** Larger items such as fishing nets (accounting for a significant portion), buoys, containers, and other floating debris.
    - **Consumer Goods:** Items like plastic bags, bottles, and packaging materials are common.
2. **Source of Waste:**
    - **Fishing Gear:** About 46% of the patch consists of abandoned or lost fishing gear (often referred to as “ghost nets”).
    - **Land-based Sources:** Around 80% of the garbage comes from land-based activities (littering, improper waste disposal), with 20% originating from marine activities (fishing vessels, boats).
3. **Size & Weight:**
    - The GPGP covers an estimated area of 1.6 million square kilometers (twice the size of Texas).
    - Estimates suggest it contains about **79,000 metric tons** of plastic, though newer research often updates these numbers.
    - **1 metric ton** = **2,204.62 lbs**

Cleanup and Amounts Collected:

What Has Been Brought to Shore So Far:

Efforts to clean up the GPGP are ongoing, primarily led by **The Ocean Cleanup** project. This initiative has developed systems to collect floating plastic and bring it to shore for recycling or disposal. The main system in place is a large barrier that passively collects debris as ocean currents move through it.

- **The Ocean Cleanup's Progress:**
    - As of recent reports, more than **100,000 kilograms (100 metric tons)** of plastic have been collected and brought to shore.
    - This effort is still in its early stages compared to the total volume, but it's considered a significant milestone for large-scale ocean cleanup.

Annual Amount Collected:

- The Ocean Cleanup's system is relatively new, so estimates on annual collection rates are still evolving.
  - In **2022**, the project estimated that their systems could eventually capture up to **10,000 metric tons** of plastic each year as they scale up operations.
  - As of now, they are focusing on expanding their system to improve the rate of plastic removal annually.

Challenges & Future Goals:

- **Challenges:** The GPGP is difficult to clean due to its size, the dispersed nature of the plastic, and the breakdown of larger plastics into microplastics. Microplastics are especially hard to capture.
- **Future Goals:** The Ocean Cleanup project aims to remove **90% of floating plastic** from the ocean by 2040. However, significant challenges remain in addressing the constant influx of new waste into the ocean.

The material collected from the **Great Pacific Garbage Patch (GPGP)** is brought to shore and processed in various ways, depending on the type and condition of the debris. However, the process of recycling or disposing of ocean plastic comes with several challenges. Below is an overview of how this material is handled and the difficulties involved.

Processing and Disposal Methods:

1. **Sorting:** Once the material is brought to shore, it is **sorted** to separate the different types of debris. Sorting involves separating:
   - **Plastic types** (e.g., PET, HDPE, fishing nets)
   - **Non-plastic materials** (such as metal objects, ropes, wood, etc.)
   - **Contaminated and non-contaminated items** Sorting is essential because different types of plastics and materials require different recycling processes.
2. **Recycling:**
   - **High-quality plastics** (like PET or HDPE) can sometimes be recycled if they are in good condition and not too contaminated. These plastics are cleaned and processed into pellets, which can be reused to create new plastic products.
   - **Fishing nets and other durable plastic materials**: Some of these are collected and repurposed into products like recycled plastic clothing, skateboards, or other consumer goods.
3. **Waste-to-Energy (Incineration):** Materials that are not recyclable, either due to contamination, degradation, or the type of plastic, may be sent to **waste-to-energy plants**. Here, they are incinerated to generate energy. However, incineration is controversial due to the potential release of **harmful emissions** (like dioxins) unless strict emission controls are in place.
4. **Landfill:** Some of the debris that cannot be recycled or incinerated might end up in **landfills**, though this is generally considered a last resort. Sending ocean plastics back to landfills is not ideal, as it just reintroduces waste into the environment.

5. **Upcycling:** Certain organizations and companies specialize in **upcycling** ocean plastic. They use the materials to create high-end products like luxury fashion items, furniture, and accessories. This type of repurposing is growing in popularity as part of the **circular economy**.

Challenges with Recycling or Destroying Ocean Plastic:

1. **Plastic Degradation:**
   - **Weathering and Sun Exposure:** Plastic that has spent years at sea has often been degraded by UV radiation, saltwater, and physical abrasion. This makes the material brittle and difficult to recycle using conventional methods.
   - **Microplastics:** Many of the plastics in the GPGP have broken down into tiny fragments, known as microplastics, which are extremely difficult to collect and process. These tiny pieces are often too small to be effectively recycled or repurposed.
2. **Contamination:**
   - Ocean plastics are often contaminated with marine organisms, oil, chemicals, and other pollutants. This makes it difficult to clean and recycle the material. Recycling facilities typically require clean and uncontaminated plastic to ensure the recycled product is high quality.
   - Removing these contaminants can be energy-intensive and expensive, which lowers the economic feasibility of recycling ocean plastics.
3. **Variety of Plastic Types:**
   - The GPGP contains many different types of plastics, each with its own properties. Some plastics, like PET (used for bottles), are easier to recycle, while others, like polypropylene or polystyrene, are much more challenging. Mixed plastic debris complicates the recycling process, as different plastics require different temperatures and processes.
4. **Logistics of Collection and Transport:**
   - After the plastic is collected in the ocean, it needs to be transported to shore and then moved to recycling or waste facilities, often across long distances. This can be costly and has its own environmental impact in terms of energy use and emissions.
5. **Economic Viability:**
   - Recycling ocean plastic is expensive compared to traditional recycling or producing new plastics. The costs associated with cleaning, sorting, and transporting the material often outweigh the value of the recycled products, making it less attractive to businesses and governments.
6. **Recycling Capacity:**
   - Not all countries have sufficient recycling infrastructure, especially for handling ocean-recovered plastics. Even where recycling facilities exist, they may not be equipped to process the heavily degraded or contaminated materials that come from the ocean.

Innovative Solutions and Future Directions:

Despite these challenges, organizations like **The Ocean Cleanup** and various NGOs are working on new ways to handle ocean plastics:

- **Advanced Recycling Technologies:** Some companies are developing new methods, such as **chemical recycling**, which breaks down plastics into their chemical components for reuse. This could be more effective for degraded ocean plastics than traditional mechanical recycling.
- **Upcycling Initiatives:** Creative approaches to upcycling ocean plastic into consumer goods and fashion items are gaining popularity, making the material more valuable in certain markets.
- **Partnerships with Industry:** Collaborations between environmental organizations and consumer brands (e.g., Adidas, Parley for the Oceans) are creating a market for recycled ocean plastics, which helps drive demand for the material.

Addressing the complexities of processing ocean plastics is still an evolving field, but continued innovation and collaboration may help to overcome some of these challenges.

Estimating the total thermal value in BTUs (British Thermal Units) for the plastics found in the ocean is challenging due to the variability in types of plastic and their distribution in the marine environment. However, it is possible to estimate the potential energy stored in ocean plastics by considering the types of plastic materials and their typical energy content.

Step-by-Step Estimation:

1. **Types of Plastics in the Ocean**:
   - Most plastics found in the ocean are made of common polymers such as polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC).
   - These plastics are derived from fossil fuels, and when combusted, they release energy in the form of heat.
2. **Typical Energy Content (BTUs) of Plastics**:
   - The energy content of different plastics can vary, but for common ocean plastics:
     - **Polyethylene (PE)**: ~19,900 BTU/lb
     - **Polypropylene (PP)**: ~19,850 BTU/lb
     - **Polystyrene (PS)**: ~17,900 BTU/lb
     - **Polyvinyl Chloride (PVC)**: ~9,000 BTU/lb (due to chlorine content, PVC has a lower energy value)
3. **Amount of Plastic in the Ocean**:
   - According to recent estimates, around **150 million metric tons (165 million tons)** of plastic are currently in the oceans, with about **8 million metric tons (9 million tons)** added annually.
   - A significant portion of this ocean plastic is made up of polyethylene and polypropylene, which are used for packaging and disposable products.

4. **Estimating the Thermal Value**:
   - For this rough estimate, let's assume that the majority of ocean plastic is composed of polyethylene and polypropylene, both with an average thermal value of ~19,900 BTU/lb.
   - **1 metric ton** = **2,204.62 lbs**.
   - **150 million metric tons** of plastic in the ocean is equivalent to **330,693,000,000 lbs** or **165 million tons** of plastic.

If we use the average thermal value of 19,900 BTU/lb, (39,800 BTU/ton) the total thermal energy value of ocean plastics would be approximately:

This gives an estimated total thermal value of **6.58 quadrillion BTUs** for the plastic currently in the ocean.

Key Considerations:

- This estimate assumes that the plastics are burned completely, which would release their full energy potential.
- The thermal value of plastic waste is not practically recoverable from the ocean due to the dispersed nature of the debris and the environmental impacts of plastic pollution.

In summary, the estimated thermal value of the plastics currently in the ocean is around **6.58 quadrillion BTUs**, primarily based on the common plastics that dominate marine debris.

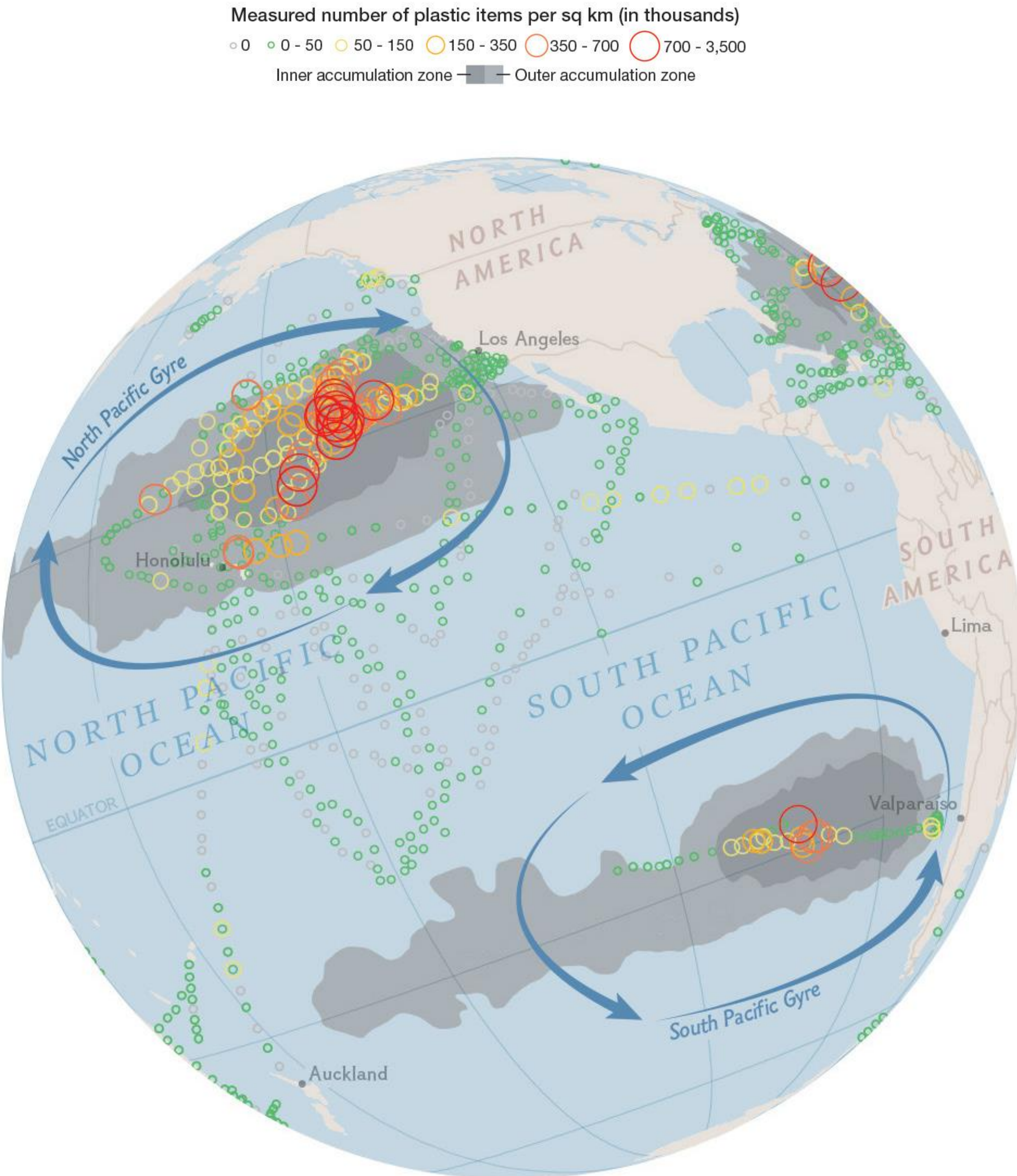
Volume of ocean plastics:

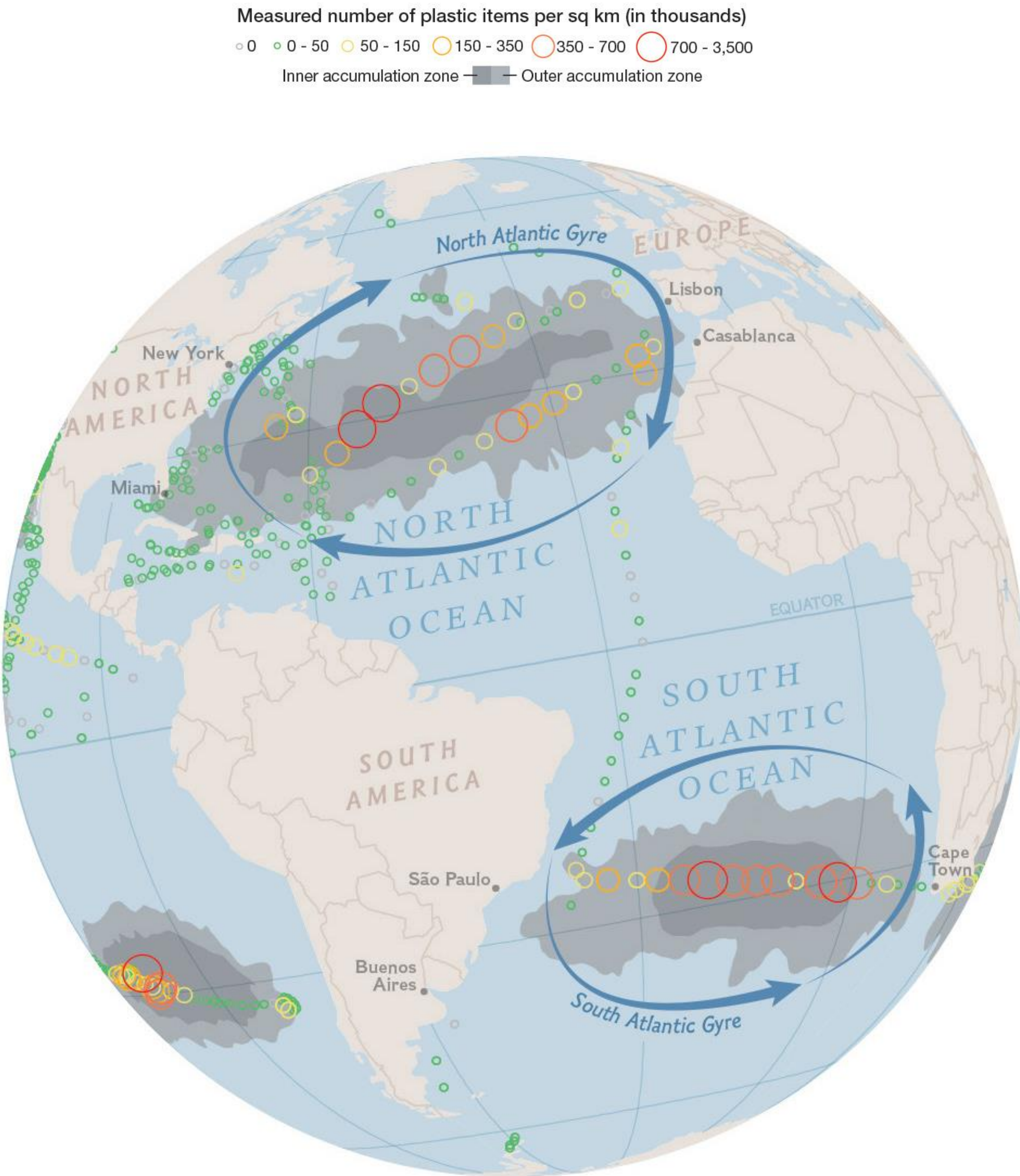
- The **GPGP** covers an estimated area of 1.6 million square kilometers (twice the size of Texas) containing 79,000 metric tons (2204.62 lbs/metric ton = 174,164,980 lbs, or **87,081 tons**) of plastic.
- Through the Ocean Cleanup project, an estimated 100 metric tons (**110 tons**) of plastic materials has been collected and brought to shore.
- Estimates are for the Ocean Cleanup project to collect and bring bring to shore nearly 10,000 metric tons (**11,000 tons**) to shore. Each *Thermo*MAX6™ could process 1,608 tons per year, requiring 7 full units. That would mean that the GPGP could be fully removed in less than **8 years**.
- **Globally**, with 165 million tons, and each *Thermo*MAX6™ processing 1,608 tons per year, it would require 10,612 full units, plus for the nearly 9 million tons added annually, it would require 5,597 units.

  10,612 standalone units at $2,682,250 for a total cost of $28,464,037,000 or $28.5 billion
  10,612 energy recovery units at $11,157,250 for a total cost of $118,400,737,000 or $118.4 billion

  5,597 standalone units at $2,682,250 for a total cost of $15,012,553,250 or $15 billion
  5,597 energy recovery units at $11,157,250 for a total cost of $62,447,128,250 or $62.4 billion

Great Pacific Garbage Patches




Measured number of plastic items per sq km (in thousands)
0
0 - 50
50 - 150
150 - 350
350 - 700
700 - 3,500
Inner accumulation zone
Outer accumulation zone
North Atlantic Gyre
EUROPE
Lisbon
Casablanca
New York
NORTH AMERICA
Miami
NORTH ATLANTIC OCEAN
EQUATOR
SOUTH ATLANTIC OCEAN
SOUTH AMERICA
São Paulo
Cape Town
Buenos Aires
South Atlantic Gyre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Bangkok
Jakarta
EQUATOR
INDIAN OCEAN
AFRICA
Dar es Salaam
AUSTRALIA
Perth
Durban
Indian Ocean Gyre
ANTARCTICA