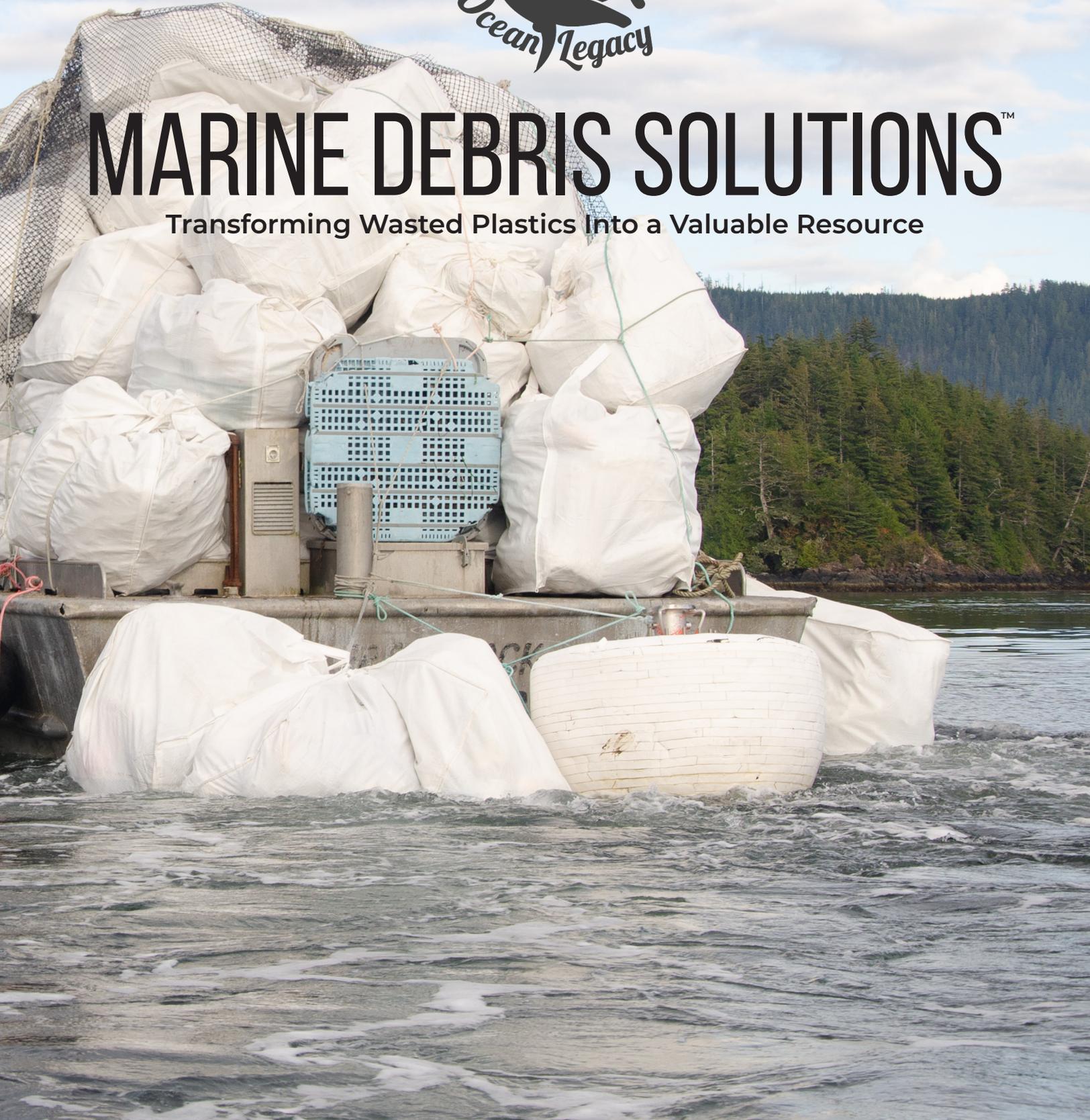




MARINE DEBRIS SOLUTIONS™

Transforming Wasted Plastics Into a Valuable Resource





This book is dedicated to all the incredibly hard working volunteers, community members, sponsors, businesses, and partners who not only make this work possible but are also creating a healthier future for all beings and future generations.

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The Ocean Legacy Foundation

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The Ocean Legacy Foundation would like to give special thanks to the following sponsors for their contributions to the making of this book:



WE ARE OCEAN LEGACY:

A FEDERALLY INCORPORATED, NON-PROFIT ORGANIZATION DEDICATED TO ENDING PLASTIC POLLUTION.



Ocean Legacy works with scientists, government, non-profits, artists, industries and concerned citizens to catalyze innovative solutions to combat plastic pollution. By working together, we create tools for communities around the world to help them clean up and manage their **post-consumer plastic** by transforming it into a valuable resource.

We believe worldwide change begins with dedicated, well-informed individual action. Our goal is to educate the public about the plastic crisis we face, and foster a global movement to end plastic pollution. Anyone can fight the devastation being caused by plastic pollution, but we all need to understand the problem.

One of the major issues we have encountered is a lack of clear and accessible information about how plastics are made and the major health effects caused by consuming plastics. We all want to make informed decisions about what we buy and how we dispose of our plastics, but this information can be hard to find. **How is it made? What is it made of? How do we dispose of it? What impact does it have on the environment?**

This handbook will provide you with a basic understanding of plastic pollution and what you can do about it.

Ask yourself: How much do you really know about plastic?

One of the many mountains of plastic pollution piled in Yuquot, British Columbia with the Ocean Legacy crew: the Williams family of the Mowachaht Muchalaht First Nation, The Canadian Coast Guard, and part of the Red Rabbit Studio film crew.

“WE’VE SEEN A PLACE WHERE PLASTIC WASTE IS SO THICK, IT OUTNUMBERS THE FISH IN THE WATER. A PLACE WHERE THE GARBAGE BURNS NIGHT AND DAY, AND EVERYONE WEARS A MASK JUST TO BREATHE.”

- The Ocean Legacy Foundation



Ocean plastics washing up on shore, filling our oceans and being burned in Mexico.

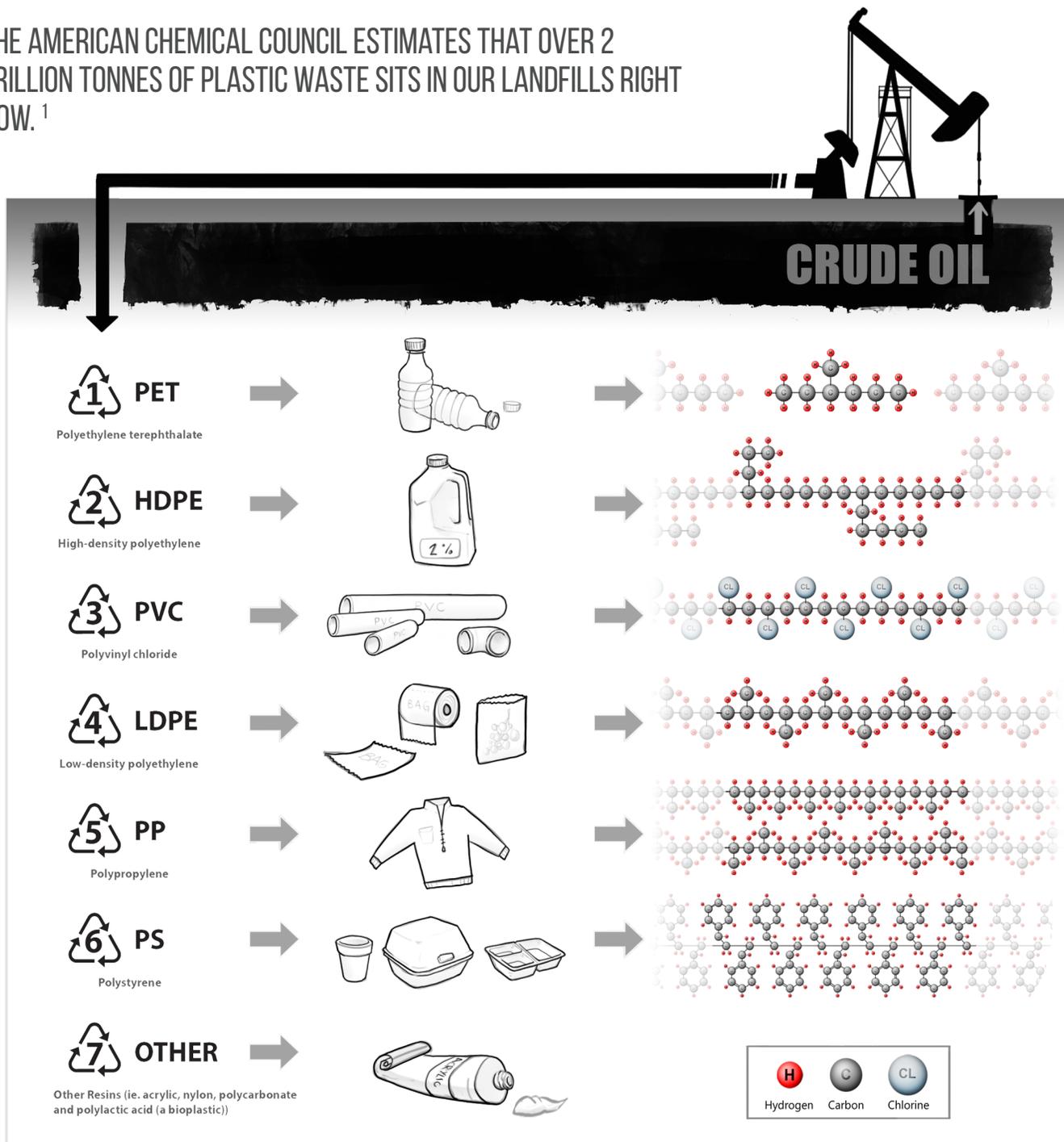


In our modern world, plastic is everywhere. Everyday, people use and dispose of it without a second thought. Huge quantities of plastic waste leak into our waterways, flowing into the ocean. From there, it's swept all over the world, converging in ocean currents known as **gyres** as well as shorelines.

Every year, more plastic enters our oceans. Once there, it kills wildlife, poisons the water, and contaminates the food we eat.

This is a global environmental crisis. If our plastic consumption habits don't change soon, we will permanently and irrevocably damage our planet. But there are solutions we can adopt create positive innovative changes.

THE AMERICAN CHEMICAL COUNCIL ESTIMATES THAT OVER 2 TRILLION TONNES OF PLASTIC WASTE SITS IN OUR LANDFILLS RIGHT NOW.¹



Above: Illustration by Andrew McKeachie

Plastic is made from **polymers**² – a chain of **monomers** formed from the same crude oil we use to create fuel, asphalt, and other petroleum products. Different chains of polymers form different kinds of plastic, each represented by a resin code. You'll find resin codes 1 to 7 on most recyclable plastics.

Check the bottom of your water bottle or the lid of your disposable coffee cup. You'll find a small number and triangle: this is the resin code. Resin codes make

it easier to sort and process the plastic after it's thrown away. Most plastics are recyclable, but many do not get recycled if they are dirty, degraded, or contain organic matter, like the plastics we collect from the shorelines and ocean.

Did you know that in North America, less than 10% of plastic materials are actually recycled?³ Many recyclable plastics end up in landfills, incinerated, dumped on land, or into waterways. Much of the world doesn't manage their

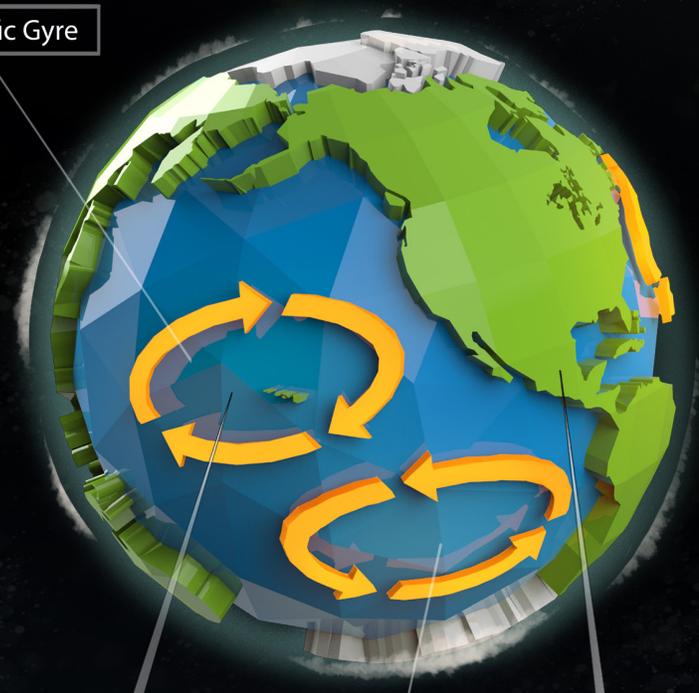
plastic waste at all – it's costly and hard to enforce recycling practices. Many governments lack the infrastructure or resources needed or ship their waste internationally to process plastics in other countries. As a result, large concentrations of plastic wash into the ocean from some of the most impoverished areas of the world. We call this problem waste mismanagement.

A SINGLE TUBE OF FACE WASH CAN CONTAIN MORE THAN 300,000 PLASTIC MICROBEADS ⁴

When plastic waste is mismanaged, it ends up in our streets, waters, fields, forests and shorelines. Wind, rain, and currents carry the plastic into rivers, lakes and oceans. It is estimated that the source of 80% of plastic that washes back up on the shore was originally from land. ⁵

Some of the worst offenders are **microbeads** and **microplastics**. These tiny particles of plastic (less than 5mm) are known as microplastics and are composed of microbeads (less than 1mm). Most of these are found in hygiene products like body wash and toothpaste. Others come from bits of polymer that detach from clothing during washing. These plastics are so small they bypass our wastewater treatment systems, spreading through our waterways, and breaking down in soil, lakes and oceans.

North Pacific Gyre



North Atlantic Gyre



South Pacific Gyre



Marine Industry



Dumping



Landfills

Main image: Andrew McKeachie
Inset images: Reetta Linjama

These are the main ways plastic gets into your oceans and waterways:

Since the 1950's, plastic has been washing out to sea and gathering in the world's five gyres. Every single gyre is now congested with plastic waste. Some sinks, some floats and some eventually drifts back to our coastlines. This plastic takes centuries to degrade, toxifying the environment, wildlife, and our bodies.

Recycling



Industrial / Open Pit Incineration



Natural Disasters



South Atlantic Gyre



Indian Ocean Gyre

IT'S ESTIMATED THAT THERE ARE OVER 5.25 TRILLION PIECES OF PLASTIC SPREAD ACROSS EVERY OCEAN ON EARTH.

Most life on Earth can't adapt fast enough to keep up with the rapid changes brought on by plastic waste.⁷

The Japanese government estimates that nearly 5 million tonnes of debris washed into the ocean due to the devastating

March 2011 tsunami. It is estimated that nearly 30% of this material floated away and dispersed, 70% sank near Japan.^{8,9}

THE OCEANS ARE BEING IRREVERSIBLY DAMAGED BY PLASTIC.

Animals mistake plastic for food, ingesting harmful pollution, becoming entangled, injured or even killed.

Entire ecosystems have become uninhabitable due to this pollution, contributing to the destruction of marine life. Scientists estimate that nearly 700 species are threatened by the effects of plastic pollution, with 120 of them at risk of extinction.¹⁰

When plastic is exposed to harsh sun, wind and water current, it begins to **photodegrade** and fragment, turning into smaller pieces.⁵ This leaches toxic chemicals, such as Bisphenol A (BPA), into the water. BPA has been linked to estrogenic hormonal imbalances in the body.¹¹ Fragmented pieces of plastic also act like a sponge, absorbing other toxic persistent synthetic compounds like Polychlorinated biphenyl (PCB) and Dichlorodiphenyl-trichloroethane (DDT).¹² These chemicals can cause abnormalities in liver function, skin and the nervous system.¹³ Once eaten by wildlife, they accumulate

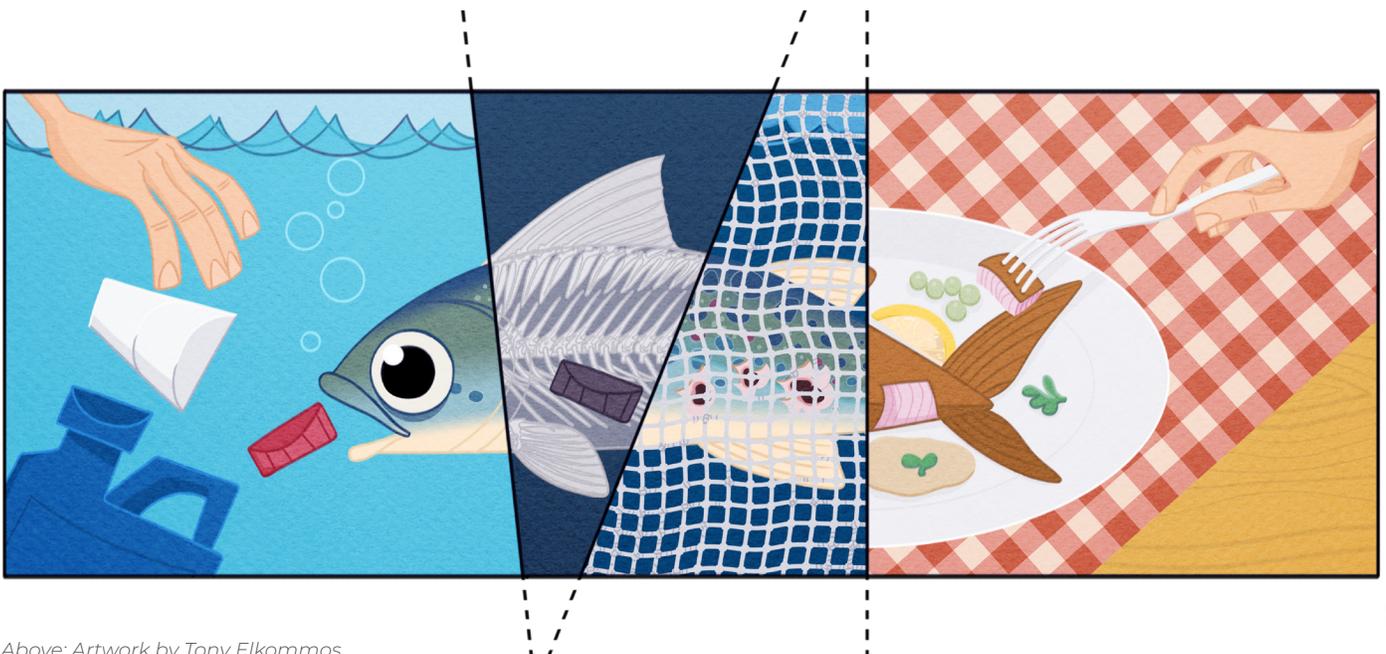


Above: Artwork by Irina Golina

in the fatty tissues of the body, a process called **bioaccumulation**. These poisons can be present in the seafood that ends up on our dinner tables.

To make matters worse, most plastic is too dense to float. It's

estimated that 70% of the plastic that reaches the ocean sinks.¹⁴ There could be enough plastic waste sitting on the ocean floor to rival mountains on land.



Above: Artwork by Tony Elkommos

PLASTIC POLLUTION WON'T GO AWAY ON ITS OWN. IT FILLS OUR OCEANS AND SHORELINES.

We need waste-reduction strategies that minimize plastic consumption and collect and contain waste. Plus, we still need to clean up the existing plastic.

It takes a lot of resources to locate, catalogue and capture the plastic waste leaking into the ocean. Ocean Legacy was founded to address this problem.

Using the interactive map on our website, you can report a plastic pollution hotspot anywhere in the world. This helps us identify areas of concern and works with locals to clean up the plastic in their communities. Our website also hosts a Global Directory of Ocean Conservation Initiatives.

Communities can use it to find and enlist local allies and resources.

Once we arrive at a Hotspot, we can survey reported plastic-congestion by counting every

piece of plastic that's over an inch in a 100m marked off area and take detailed photos using drones. These surveys follow the National Oceanic and Atmospheric Administration (NOAA) survey guidelines. This helps us track the composition, volume and reaccumulation rate of material washing up on shore. We can then gather the debris and bring it to a location where it can be sorted for upcycling, and some converted into fuel using plastic-to-fuel technology.

Our operations vary based on location, the kind of debris and volume we find, and who we are working with. Each of these factors determines the most effective strategy for managing a hotspot.

While on expedition, we spend weeks living on boats and camping on shorelines. It's difficult and often dangerous, but always rewarding work. We travel to places where few humans have ever set foot. We

meet beautiful creatures that have adapted to unique environments. Too many of these places are being destroyed by plastic.

Out on the ocean, the immensity of the problem towers over us. In every water sample we take, on every beach we visit, we find plastic pollution. Plastic pollution is hard to quantify. It collects on every shoreline differently and ocean currents continually shift it around the world. Still it's common for us to collect 2 to 3 tonnes of material in less than 1 km of shoreline. This is just a fraction of what's out there. It's estimated that 13 million tonnes of plastic is dumped into our oceans every year. What's worse, plastic production is expected to double by 2025.¹⁵

The amount of plastic pollution entering into the ocean is the equivalent of one dump truck full of plastic being emptied every minute!¹⁶



Above: Artwork by Irina Golina

Plastic pollution is a result of waste mismanagement and plastic over-consumption. In many developed countries, governments have instituted recycling programs. However, many of these are ineffective and resort to shipping waste to other countries for landfill and post-processing. It is estimated that even with expensive recycling programs in place, less than 10% of North America's total plastic waste is actually recycled.¹⁸

For years, wealthier countries have been paying to ship their waste to other developing nations. Many of these nations don't have adequate infrastructure to manage these wastes – so it just ends up back in our environment. Tonnes of plastics are simply burned in an open pit. The United Nations estimates that between 22-43% of rural communities practice uncontrolled burning. This isn't a solution – it spews more carbon dioxide and harmful dioxin substances into the air.^{19,20}

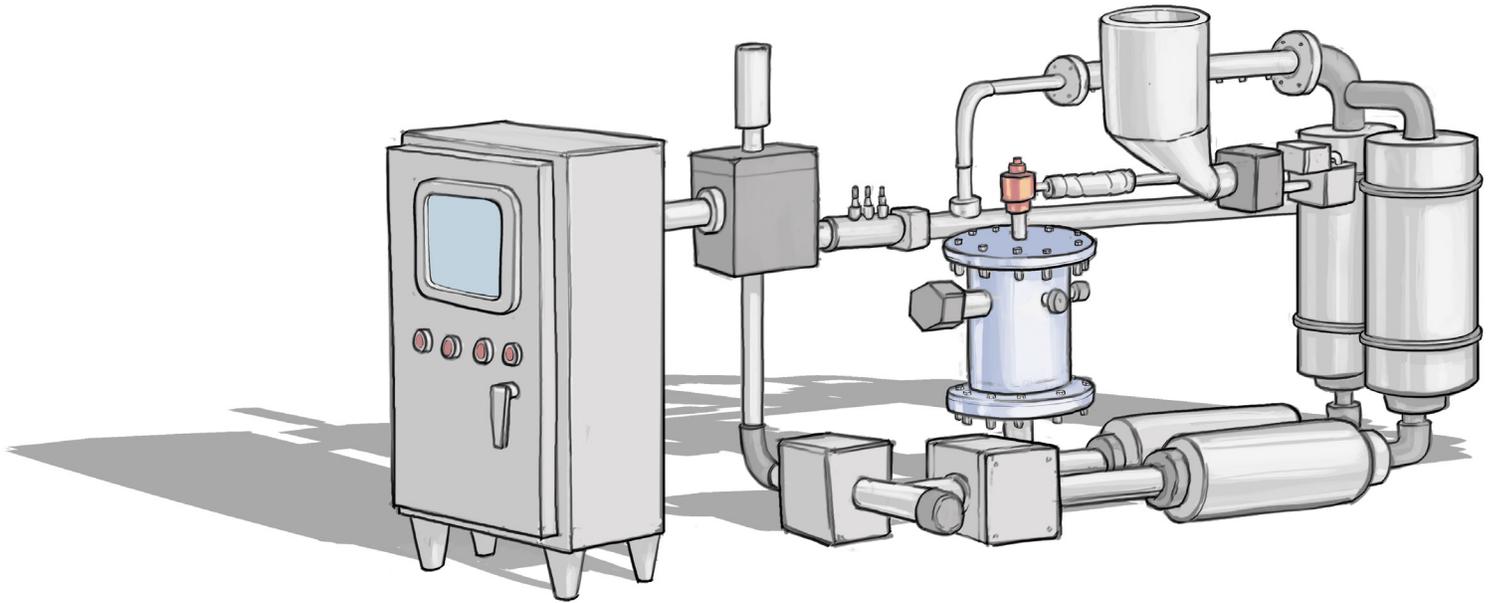
The rest of the plastic ends up in landfills, city streets, the countryside and waterways. Plastic from every country on Earth continues to make its way into our water, soil and atmosphere.

PLASTIC POLLUTION KNOWS NO BORDERS.

IT DOESN'T STAY IN ONE COUNTRY. WASTE MISMANAGEMENT AFFECTS THE ENTIRE PLANET.



AS WE CONTINUE OUR SEARCH FOR WAYS TO RE-USE AND UPCYCLE PLASTIC WASTE, ONE GREAT INNOVATION IS THE PLASTIC-TO-FUEL MACHINE



Above: Plastic-to-fuel machinery
Artist's rendering: Andrew McKeachie

Plastic is made out of oil and plastic materials can therefore be converted back into a usable fuel using this technology.

Using microwave frequencies to decompose plastics through heat, this technology gasifies plastic polymers inside an oxygen-free chamber. This process is called **pyrolysis**. Then using differences in temperature, it distills the gases back into a mixed light crude oil, individual fuels or valuable chemicals.

With this process, Ocean Legacy can produce a light crude oil or further refine it into diesel, petroleum and kerosene fuel. For every kilogram of plastic processed, we get roughly one litre of oil. Some of this fuel will go back into running the equipment and vessels we use, while the rest goes back to the community we've helped clean up.

Plastic-to-fuel technology reduces our dependency on traditional virgin oil extraction enables us to produce a recycled oil while we continue to develop renewable sources of energy.

80% of the world's population lives on less than \$10 (USD) a day²¹. People living in poverty are concerned with survival, not plastic pollution. Programs which use tools such as plastic-to-fuel technology are able to transform a valueless waste product into a new valuable resource. This provides an **economic incentive to collect plastic waste** and is a means of creating alternative fuel sources to further fund initiatives that protect our environment and enhance our global communities.

We can make oil out of almost any plastic item and can upcycle resins such as polyethylenes, polypropylenes and polystyrenes (resin code #2, 4, 5 and 6). Material resin codes 1, 3 and 7 are harder to process as they're often mixed compounds or contain substances that can't be pyrolyze efficiently.

Many plastic-to-fuel operations are large in scale, and heavy making transportation impractical and operations costly. Many communities also don't produce enough plastic or can't afford their own plastic-to-fuel machine to justify its expense. This is why we've partnered with Resynergi

Inc and their team of engineers to custom-build a small scale mobile plastic-to-fuel machine that can travel to various communities located in different areas that need assistance to sustainably manage plastic wastes.

The plastic-to-fuel machine is a pilot project that will help transform plastic waste into a **valuable resource**, giving these once worthless materials economic value. With this technology, we can fuel and sustain our efforts as well as create an economic return in cleaning up the natural environment. We hope others will use our program as a model for similar plastic litter post-processing systems across the world.

THE PLASTIC POLLUTION EPIDEMIC IS TOO BIG FOR ONE PERSON OR GROUP TO SOLVE. IT MUST BE ADDRESSED ON A GLOBAL SCALE.

The plastic-to-fuel machine and this handbook are intended to spread awareness around the effects of plastic pollution, reduce plastic waste, and offer a sustainable solution to process these resources.

We've had strong positive responses from organizations, communities, and companies all over the world. Many individuals have dedicated their lives and careers to this cause. Their work must spread across the globe to end waste mismanagement.

There are many initiatives being organized all over the world to help address this issue. Projects like the Gulf of Alaska Keepers, The Ocean Cleanup, Parley and Clean Oceans International are organizing cleanups, continuing important research, and creating innovative strategies to manage and reduce marine debris. The world is waking up to help solve the plastic crisis. The United Kingdom and the European Parliament have now banned single use disposable plastics. Over 127 countries are now taking steps to ban an array of single use disposable items such as bags, straws, cups and cutlery. Countries and large corporations that use single use plastics are doing many things to change the way plastics are managed. Some of these solutions include: putting a tax on certain items to discourage their use and pay for their management, setting reduction and recycling targets, adopting legislation that either restricts their use or bans it, offering payments to return plastic items, and setting up up collection centres which enable people to earn some money by returning items such as bottles or various plastic containers.

Other initiatives such as the United Nations Clean Seas Campaign through United Nations Environment is leading a comprehensive global campaign to combat marine litter by getting countries and initiatives to sign on to their platform to unify global action against plastic pollution.

HOW CAN YOU HELP?

Sometimes, advice about minimizing pollution feels like another check-list and taking action as an individual can feel overwhelming. Many of us want to see a specific result but have no idea how to take steps to get there.

Here are some steps you can take to reduce your plastic consumption, the waste you create and how you can clean it up:



Above: Karla Robinson along with volunteers Adam Wharram and Jean-Francois Savard from the Vancouver Island Surfrider Foundation organize approximately 10 tonnes of marine debris on the Keith Island dock in the Broken Group Islands, British Columbia. It is estimated that 12 to 15 tonnes of debris were collected in total during August 2016 with the assistance of 5 different volunteer groups. Photo: Liya Herb

HELP OCEAN LEGACY:

Spread Our Message: Give this book to others, link them to our website, like and share us on Instagram, Facebook, Twitter, and other Social Media. Tell people about us – especially if they say they feel like they don't know what to do! People can use this book to learn about how to separate resin codes, get involved in plastic-to-fuel programming and continue cleaning hotspot locations after we're gone.

Report Hotspots: If you see plastic washing up on shore, or floating in the ocean, let us know! Log on to oceanlegacy.ca and use our interactive map to add Hotspot locations.

Donate: We are a federally incorporated non-profit organization, and we accept donations. Even if you can't donate funds directly, we are always in need of non-perishable food items, first aid supplies, office supplies, fuel, and other in-kind donations.

Support Plastic to Fuel Technology: Spread the news to your friends, family, and colleagues. If you know of a community that could benefit from implementing plastic-to-fuel in their community, let us know.

Create your own plastic diversion program: If your community doesn't recycle then create your own recycle zones. Check out our cut-out signs at the end of this book to get started. Talk with us about how to bring plastic-to-fuel technology to your community, or how to get connected to plastic recycling solutions.

CHANGE THE CULTURE:

Raise Awareness: Just talking about these issues and explaining the dangers will help the cause! Share on social media, engage with people who ask legitimate questions, and if you have any kind of audience - blog readers, video viewers, or twitter followers, let them know.

Vote Green: Choose politicians with pro-environmental policies. Vote in favor of initiatives and referendums that protect the environment. Make sure your elected officials know that the environment is a high priority for you. If they don't listen, find politicians that will.

Volunteer: Many local initiatives need volunteers to help with every part of their work - spreading info, cleaning beaches, recycling plastic and more! Oceanlegacy.ca website has a global directory of various ocean conservation initiatives. Find the one closest to you and contact them.

Make art out of the debris you collect.

Share your own solutions: Got ideas? Let everyone know. Share your upcycling and waste reduction ideas in person or over the web.

STOP PLASTIC WASTE:

Reduce/Reuse/Repair/Recover/Recycle/Refuse/Rethink: The 8 Rs are simple and free ways to stop plastics from reaching the landfill! Cut as many "disposable" single-use plastic items you can from your life - razors, bottles, containers, etc. For things you can't give up, try to re-use them as long as possible. When they're worn out, bring them to a dedicated recycling facility if possible.

Stay Curious - Before throwing something away, ask: "What happens to this item once it's thrown away? Can it be turned into anything else? How can I make this "garbage" into a resource? There are tons of life-hack tips on how to repurpose items for all kinds of everyday use.

Buy Green Products: Many companies are converting to biodegradable plastic alternatives, or switching to greener materials like wood or paper. Purchasing these products demonstrates that you support their policies and better practices.

Don't buy stuff with lots of packaging: Demand alternatives by providing feedback to places where you shop and manufacturers of the things you use.

Start your own clean-up crew: Be the change you want to see in the world! You can pick up plastic waste anywhere you see it, anytime, and make sure it's recycled.

CHANGE IS FOR ALL OF US

Change is possible, but only if we come together across the globe, working towards a better future. Alone, we could never make this happen – but together, anyone and everyone can contribute to creating cleaner oceans. We need a **worldwide effort** – millions of hands, hearts, and voices, all making changes to their local waste management systems and plastic consumption habits.

You don't have to dedicate your whole life to it, but if everyone spent a few hours a week on reducing waste and cleaning up plastic, there would be a noticeable improvement worldwide.

Looking ahead, we have the chance to make things better, or worse. Let's leave a legacy we can be proud of!

Ocean Legacy will continue to build a healthier planet for present and future generations. If you'd like to find out more, please visit us at www.oceanlegacy.ca and get involved!



Artwork by Tony Elkommos

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**RECYCLE
HERE**

**RECICLAR
AQUI**



**PETE Water Bottles
Botellas de Agua**

**RECYCLE
HERE**

**RECICLAR
AQUI**



**Hard Mixed Plastic
Fragments**

Plásticos Mezclados Duros

**RECYCLE
HERE**

**RECICLAR
AQUI**



**Styrofoam / Unicel
Mixed Foam
Broken Foam Buoys**

CREATE YOUR ZERO WASTE CLEAN UP

1 - RUBBER

End-of-Life Solutions: Mix into cement for filler, recycle into new rubber, use in art projects.

2 - HARD MIXED PLASTIC FRAGMENTS

Large jugs, baskets and fragmented pieces of plastic

End-of-Life Solutions: Recycle into new plastic items, plastic-to-fuel processing, compress into housing construction material.

3 - COLORED PLASTIC CONTAINERS & BOTTLES

*Pure HDPE and PP
Small jugs and shampoo bottles*

End-of-Life Solutions: Plastic-to-fuel processing, recycle into new plastic items.

4 - WATERBOTTLES

PET

Remove the cap (HDPE or PP) & pour out any water/liquid.

End-of-Life Solutions: Recycle into new plastic items.

5 - FOAM

*Clean white foam (PS)
Dirty foam (PS)
Yellow/brown foam & fishing floats (Urethane)*

End-of-Life Solutions:

Clean White Foam: Upcycle into construction materials, plastic-to-fuel processing.

Dirty Foam: Plastic-to-fuel processing.

Urethane Foam: Upcycle into new urethane foam and fishing floats.

6 - BUOYS

*Good buoys (HDPE, PVC, MIX)
Broken buoys (HDPE, PVC, MIX)
Cork floats (Cork)*

End-of-Life Solutions:

Good Buoys: Use in art projects, reuse in industry.

Broken Buoys: Shred and make into new plastic items.

Cork Floats: Use for insulation and art projects.

7 - ROPE

Mixed rope (Nylon, PP, Mix)

End-of-Life Solutions:

Nylon: Upcycle into running shoes and other fabrics.

PP & Mix: Recycle into new plastic items.

8 - LANDFILL

End-of-Life Solutions: Landfill should only be used if nothing else is possible.

9 - METAL

Aluminium, Steel and Mix

End-of-Life Solutions: Recycle into new metal items.

10 - PLASTIC BAGS & SOFT PLASTICS

LDPE

End-of-Life Solutions: Upcycle into fuel, recycle into new plastic items.

11 - GLASS

End-of-Life Solutions: Recycle into new glass, use as insulation.

12 - SHOES & FLIP FLOPS

End-of-Life Solutions: Use in art projects.

13 - MATERIAL & TEXTILES

End-of-Life Solutions: Mix into cement for fillers, recycle into new materials if possible, use in art projects.

14 - WOOD, PAPER & CARDBOARD

End-of-Life Solutions: Compost materials, recycle into new paper products.

15 - TIRES

End-of-Life Solutions: Recycle into new tires, repurpose into housing material.

