

SHORE ZONE (SZ) MICRO-BARGE
CONCEPT FOR SPILL RESPONSE TO
SUPPORT TACTICS, LOGISTICS, AND
WASTE MANAGEMENT AS WELL AS
COMMUNITY INTERESTS

SZ Micro-barge expands the suite of tools available for spill response and operates in the diverse working conditions of Canada's arctic to temperate marine/inland waters. It applies to storing and transporting recovered oils of all viscosities, weathered states, mixed with debris, and non-oiled wastes. It can function under operating environments such as shore zones, rivers, tundras, and ice flows. An SZ Micro-barge can be used throughout an incident for logistics (boom transport) and by the community between incidents (harvesting). It can be used throughout the course an incident for logistics (boom transport) and by the community between incidents (harvesting). It never becomes a stranded asset between and during an spill incident.

The Concept

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**SHORE ZONE (SZ) MICRO-BARGE CONCEPT FOR SPILL RESPONSE TO SUPPORT TACTICS, LOGISTICS,
AND WASTE MANAGEMENT AS WELL AS COMMUNITY INTERESTS**

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October 2022

About EnviroEmerg Consulting

EnviroEmerg Consulting focuses on emerging regional, national, and international environmental issues related to oil and hazardous material spill risk, prevention, preparedness and response. Sectors include transportation (vessel, rail, road, pipeline) and industrial (manufacturing, storage). Clients include government, companies, First Nations and non-government organizations. Stafford Reid (Principal) has 48 years of experience in environmental management.

Purpose

A *Shore Zone (SZ) Micro-barge* Improves oil spill response in Canada by providing an adaptation to conventional storage and transportation of oily wastes as well as debris to improve recovery outcomes.

The *SZ Micro-barge* expands the suite of available spill response technologies in the diverse working conditions of Canada's arctic to temperate marine/inland waters. The *SZ Micro-barge's* approximate size is 5.5 meters (18 feet) LOA, 2.3 meters (7.5 feet) wide, and 1.2 meters (4.0 feet) high. It would have a cargo capacity of approximately 4 cubic meters (5 cubic yards). This provides an oil capacity of 4,000 litres (25 US barrels). See Figure 1 and Appendix 1 for Design Specifications

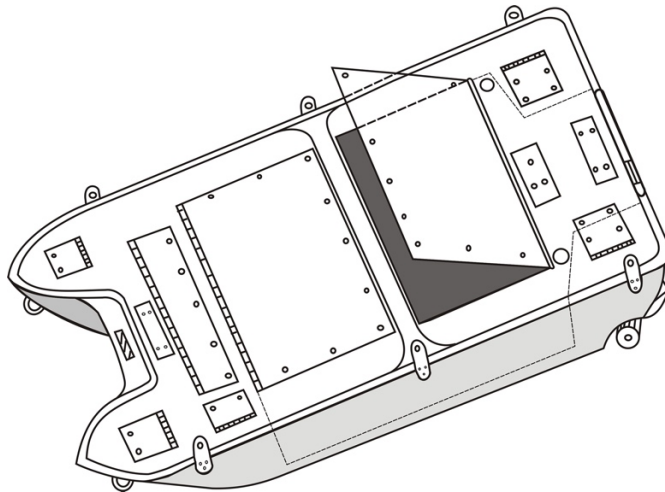


Figure 1 - SZ Micro-barge Sketch - Not to Scale

EnviroEmerg Consulting: Shore Zone (SZ Micro-barge) Concept

It applies to storing and transporting recovered oils of all viscosities, weathered states, mixed with debris, and non-oiled wastes. It can function under operating environments such as shore zones, rivers, tundras, and snow/ice conditions.

An *SZ Micro-barge* fills the gap of achieving uninterrupted loading of recovered oil and/or debris - on-water and onshore - to a final disposal location that is efficient, safe, and clean. *SZ Micro-barge's* design and construction allow it to work within the rugged and hazardous shore zone that larger barges cannot reach safely as being too big or not rugged enough.

It ensures operational oil recovery is not impeded or ceased if temporary storage cannot meet demands. This is because an *SZ Micro-barge* provides a seamless sea-to-land transport of wastes to a final disposal facility without intermediate off-loading.

The waste storage and transport solution are scalable in that number of *SZ Micro-barges* can be expanded when needed - potentially ubiquitous throughout a region. There can be economies of scale in its production.

The *SZ Micro-barge's* final design to meet operational functions during a spill incident and for a coastal/inland community between incidents is contingent on collaboration with first responders, Indigenous organizations, regulators, testing facilities, engineers, and manufacturers.

Having *SZ Micro-barges* dispersed throughout a region's local spill response capacity development, whether it's owned/managed by a marina, forestry, aquaculture, or eco-lodge company that stores fuels on-site or by a First Nation's government (Band/council) for its emergency preparedness and coastal management services. All these response assets can come together for a large spill.

The Challenge

The challenge is to design an *SZ Micro-barge* that can be used during and after an oil spill and/or release non-oil pollutants such as debris from a vessel's containers and other cargo. Design elements include dimensions, weights, materials, features, etc., to meet spill logistical and tactical requirements and the needs of a coastal or inland community's daily uses. Both spill operations and community services go together in the *SZ Micro-barge's* applications.

A Paradigm shift in Spill Preparedness

To set-the-stage for an *SZ Micro-barge*, there requires a paradigm shift in Canada's spill planning, preparedness, and response to:

1. Recognize the importance of an initial response by communities, particularly First Nations - which is referred to as Tier 1 local response.
2. Acquire response equipment with multiple uses during the entire course of a spill incident as well as between incidents to serve a community - which ensures an optimal return on investment
3. Utilize boating skills and navigational knowledge of local coastal and inland residents to operate small vessels, such as their skiffs, herring boats, landing crafts, etc., that can deploy small-scale response equipment - which empowers a community.

4. Understand that pollution recovery is not well developed within a coastal shore zone, such as in and amongst coves, channels, crevices, reefs, and kelps - which is the last opportunity to prevent oil and debris from stranding on shores.
5. Realize that the current transport of oil or debris recovered on water requires multiple transfers and storage steps that are costly, inefficient, and pose health and safety hazards to responders - which needn't be the case.

The Problem & Solution

Spill equipment such as booms, skimmers, recovery vessels, and oil storage barges is designed for a future, a specific type of event. During and between incidents, single-purpose equipment often becomes a “stranded asset” with no other function or utility to the response efforts as it unfolds and later to a community between incidents. The *SZ Micro-barge* concept enables the use of this asset throughout the incident – from supporting the movement of tactical equipment (logistics) to managing the transport of wastes recovered from on-water and on-shore.

When not engaged, an *SZ Micro-barge* would have diverse uses for the coastal community, such as supporting subsistence fisheries, aquaculture activities and marine debris cleanup programs. An *SZ Micro-barge* can be used as storage for spill equipment such as booms, ropes, and skimmers. This grab-and-go approach can be for spill preparedness of a company that stores fuel on its site or a First Nation's government to support their Geographic Response Strategies.

Wastes generated and recovered from a vessel casualty or a facility accident can include fresh fluid oil, weathered thick oil, oiled soaked sediments/debris, oil-contaminated booms, and non-oiled materials such as container vessel's lost goods and other cargos. An *SZ Micro-barge* can use its top hatches for debris, super-sacks, booms, or - when closed and sealed - use its hose-fitting for mobile, pumped oil or oily water—currently, barges store and transport only one product type.

A waste management system to transport products from their source to final disposal should be seamless. This is different from the current situation in Canada. The result could be more efficient and chaotic temporary waste storage. The norm is a multi-step process whereby wastes are handled several times. For recovered oil, it is first pumped out of the response vessel into a barge or floating bladder, towed and off-loaded to temporary storage on shores, reloaded again for land transportation over roads, and finally off-loaded to a final disposal site/facility. Each step incurs a cost, delay, and worker exposure. There are more chances of spillage and increased contamination of equipment.

Poorly designed waste storage/transport equipment and the process can stop operations. An *SZ Micro-barge* can remedy this situation. An *SZ Micro-barge* allows recovered oil, debris and other wastes to go from the collection site directly to final disposal. It is only opened or unloaded once it reaches its destination, then returned to service fully operational. It is a *Roll-off* garbage bin system commonly seen on roads but designed for sea, river, lake, tundra and ice conditions.

There is a saying in the spill response community “that one can't have tactics without logistics.” At the onset of an oil spill, the challenge is to get booms and skimmers to a priority coastal location to contain it at the source or exclude it from threatened areas, such as beaches, marshes, marinas, water intakes, etc. This means going to many different places simultaneously. It can become ineffective to rely on a few large vessels to make multiple stops to unload – *i.e.*, a “milk run” approach. Smaller transports can be more

pragmatic and practical, such as using *SZ Micro-barges* – as per the above-mentioned “grab-and-go” approach.

Once finished with the logistics of transporting containment/protection booms, an *SZ Micro-barge* is then used to haul oil/debris recovered during on-water operations directly to a final disposal site. Whenever mobile oil (or debris) is stranded onshore, an *SZ Micro-barge* reverts to moving shore treatment equipment, storing collected wastes, and finally transporting shore wastes to a final disposal site. It never becomes a stranded asset from the beginning to the end of a marine incident.

Depending on the locale, responders may work in various working environments such as offshore, nearshore, onshore, next to rocks, on ice and in muskeg/wetlands, and during extreme hot to freezing temperatures. During a significant incident, equipment is cascaded, often unsuitable for the operating conditions. An *SZ Micro-barge* would be designed for all working environments. They can be sized for mass transport by shipping containers and flat deck trucks.

Once engaged, an *SZ Micro-barge* can be towed by a small boat; several towed in tandem by a larger one; self-propelled by a small outboard motor; airlifted by a helicopter; or dragged by an All-Terrain Vessel (ATV) over rock, ice or muskeg. Attachment accessories could be used empty as temporary inland-floating bridges for stream/river crossings and between ice flows to accommodate an ATV or a small truck. Bridge construction is significant for an inland oil spill within tundras, braided rivers, and wetlands. Docks must often be built to reach shores with unsuitable bathymetry and/or high wave exposures.

Most dedicated response equipment becomes a stranded asset, sitting idle for years until the next emergency. In contrast, an *SZ Micro-barge* can be used creatively to serve a community when not in emergency mode. It reflects the adage: “Use it or lose it.” It offers a good return on investment to be continuously used.

Non-emergency uses can be based on local needs and the imagination of a coastal community, such as a First Nation. Example applications include:

- Used to move aquaculture products
- Stationed on-site equipment with scientific equipment for marine monitoring
- Support a shore-debris cleanup program
- Storage of:
 - Dedicated spill response equipment (booms, skimmers)
 - Community emergency resources/supplies
- Depurating of shellfish to purge contaminants
- Used as a food locker
- An emergency shelter for remote travellers when placed on its side with open hatch doors and a tarp cover
- Transport of supplies to and between communities
- Temporary bridges for ATVs or small trucks.

SZ Micro-barges spread throughout a region need to be located for immediate use during a spill incident. Response resources spread out are referred to as “distributed” rather than “staged” equipment. The latter are resources in one location, such as a warehouse or sea container. There are advantages to both

approaches. Having built-in Geo-Position System (GPS) trackers and a notification management system helps locate each *SZ Micro-barge* within a local community.

To further explore an *SZ Micro-barge* as a distributed asset within a community, look at the current coastal debris cleanup programs. An *SZ Micro-barge* is specifically designed to work in the shore zone near rugged shores, rocks, and dragged-on shores. It can be used for debris trapped in coves, channels, and crevices or stranded on shores by tossing the debris into the *SZ Micro-barge's* open hatch or loading it with super-sacks. In the event of either an oil spill or container incident with debris fields, these *SZ Micro-barges* can be called on with locally-sourced trained and skilled operators that understand their functionality and ruggedness in challenging working environments. The *SZ Micro-barge's* hatches are securely sealed for mobile oil to prevent spillage. Hose fittings from skimmer pumps are used to load, and a stern gate valve to unload. If lose oily debris, unloading is by a stern dump-flap like those of a Roll-off bin.

To foster ubiquitous availability as a dispersed asset, anyone who purchases an *SZ Micro-barge* for non-emergency community services can be provided with a subsidized cost on the condition that it is made available for an incident and agree to 24/7 GPS tracking when not engaged in an emergency. The latter is a technological feature of the *SZ Micro-barge* for resource tracking, security, and load status. Companies that store fuels on-site - such as salmon farms, logging camps, eco-tourism lodges, and marinas or a First Nation's Band/Council - could also receive a subsidized *SZ Micro-barge* to encourage local (Tier 1) response capacity building.

Strategy & Tactics with a Focus on the Shore Zone

As the term "micro" infers, an *SZ Micro-barge* will not be as big with a large capacity to hold equipment or wastes as the standard "mini" barges. At 6 metres, an *SZ Micro-barge* would have approximately four tonnes of oil capacity compared to a 12 metres mini- barge's 40 tonne used by *Western Canada Marine Response Corporation*. The strategy is to have many *SZ Micro-barges* within a coastal community, making them ubiquitous. The tactic is to take a "swarm" approach where many are deployed with specific tasks and places to go. Mutual aid or establishing a co-op of shore zone protection resources builds regional capacity. This is referred to as Tier 1 local response capacity building.

A significant gap in Canada's spill logistics and operations is the capability to work and recover oil and debris within the shore zone before it strands onshore to become embedded in sediments, logs and vegetation. This is the last opportunity to recover the pollution. Once these contaminants are stranded on a shore, removing them is an expensive, protracted, unsafe work project. The shore zone is that narrow region amongst islets, reefs, crevices, surge channels, shallows, and kelps. It is where advancing oil recovery vessels and larger barges cannot operate. The shore zone also includes the fringe around lakes and rivers. For these inland locations - as well as on tundra and ice - this domain is defined by small equipment such as All-Terrain Vehicles, jet & fan boats and Lund fishing boats. An *SZ Micro-barge* would be scaled, designed and constructed to be dragged over wetlands, rocks or towed by vessels and ATVs of opportunity sourced within a community and by the residents. In all working scenarios, local knowledge of navigation/terrain hazards and boating skills comes into play.

Floating trapped shore zone oil/debris appears to be easy to recover - which it is not. Communities often self-deploy and self-direct to retrieve it from their small vessels or reach for the oil from shore using crude rakes, shovels and pads (See Appendix 2 with images of operational context). They will be

frustrated by the lack of action if told not to respond. Worldwide, the practice and technologies haven't evolved. Figure 2 shows two oil spills in California that make the case.



Figure 2 - Shore zone recovery of mobile crude oil: rakes, shovels, sorbents and open storage containers
1969 Santa Barbara Oil-rig Blowout, 2021 Orange County Pipeline Spill

An SZ Micro-barge wouldn't be the work platform *per se* but a resource for smaller vessels to off-load oil in any weathered state (fresh, emulsified), oiled debris or non-oil debris (Styrofoam, nurdles). The SZ Micro-barge would have open hatches for manually recovered heavily weathered oil and a hose-pipe fitting for tools such as a brush/vacuum skimmer for fluid oil. The objective is to keep messy oil or debris from being stored in small recovery vessels.

Figure 3 shows a non-oil application of *the SZ Micro-barge*, which can be used to store recovered floating, trapped Styrofoam or plastic nurdles from a container that breached on shores. These are more ecologically insidious than oil once embedded in a shore's sediments and woody debris. Plastics and Styrofoam don't degrade and can be fed by birds, fish and mammals.



Figure 3: Floating Styrofoam from a single, breached container within the shore zone.
(2021 Zim Kingston container Incident - West Coast of Vancouver Island)

Integration with Other Shore Zone Response Resources

Staying within the challenging shore zone work environment, a company that has shown innovation in designing, building, and marketing equipment is *Lamor's Seahunter*, a multipurpose work platform (<https://www.lamor.com/equipment/seahunter-work-platform>). See Figure 4. Where the *SZ Micro-barge* fits is that it offers significantly more oil/debris storage than the on-board tote (1000 litres) as it comes alongside receiving recovered wastes.



Figure 4 - Lamor Seahunter work platform: two units attached in tandem with an onboard oil storage tote.

An international workboat building company that recognizes the merits of High-Density Polyethylene (HDPE) as an indestructible construction material is *Tideman's Boats*. With many different types of workboats, this company has regional representation worldwide. See Figure 5. (<https://tidemanboats.com>)



Figure 5 - Tideman Boats - HDPE construction. Two examples of many configurations, sizes and purposes.

An *SZ Micro-barge* is ideal for holding and transporting an innovative Harbo Technologies Rapid Response Boom product. This boom is packaged in compact cartridges, each containing 15 meters (50 feet) of boom weighing about 20 kgs (43 lbs.) See Figure 6. It works like a general-purpose boom with less than 1/5th of space requirements. An *SZ Micro-barge* could hold about (120 meters [400 feet]) of this boom

within its cargo area, with more room on its top deck for about another 60 (200 feet) of the boom. This product is internationally mainstream with the oil spill response community.



Figure 6 - Harbo Technologies - Rapid Response Boom
(<https://www.harbo-technologies.com>)

Operational and Design Factors

It is a significant marine architect challenge to design an *SZ Micro-barge* to be suitable and durable in extreme working environments such as semi-protected sea conditions, on-rivers, in hot summer to freezing arctic temperatures, dragged onto rocky shores, over ice flows, loaded onto trucks, airlifted and more. See Appendix 2 for design and specifications. It must be multifunctional to:

- Towed singularly and in tandem by small boats
- Store and discharge fresh to viscous oils as well as dry products
- Store and dump wastes (debris, sorbents, booms) manually loaded loosely or packaged in Jumbo (super sack) bulk bags
- Air liftable from a helicopter when empty
- Sized to be:
 - loaded on a flat deck
 - rolled off and on with a commercial waste bin truck
 - stacked into a shipping container
- Configured as a pontoon bridge or dock to hold the weight and width of an ATV when aligned longitudinally or a loaded small truck when aligned side-by-side
- Heat stored heavy, solidified oil to facilitate removal by pumps or draining.
- Decant of oil and water to maximize storage.
- Support decontamination of equipment when used as a work platform whereby the oily water is directed to the cargo hold.
- Store equipment or supplies when not in use

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Design factors need to include what primary spill response features could also be used to serve a community, such as a First Nation for kelp harvesting or a salmon farm for product transport. One needs to be cognizant of a community's boats and vehicles that can tow an *SZ Micro-barge* or move it overland.

Based on the applications outlined above, the following explores an *SZ Micro-Barge's* construction and other features:

- Built from High-Density Polyethylene - HDPE - that could be constructed by 3-D printing for production
- Double-hulled construction, whereby the hull space can be used for steam/water heat to soften solidified oil. Double hull provides added product protection from spillage due to a collision and grounding.
- Readily cleaned/decontaminated with measures to avoid trapped oil
- Hatches are sealed to prevent spillage when towed in water and transported by vehicle
- Handles hazardous and noxious substances in a sealed, responder-safe manner
- Marine navigation lights, including those for towing
- Helicopter liftable when empty - weight less than 2000 lbs
- Land-crane liftable when full-loaded as being structurally strong with adequate attachments
- Road trailerable and street-legal
- Capable of being lifted by a commercial construction (bin) truck equipped with a hydraulic arm/hook (Roll-off Function)
- Fresh oil input fittings are compatible with hoses attachments used in the response industry
- Fresh mobile oil without debris can be removed topside by pumps or from the bottom passively (*e.g.*, drained) by a gate-valve
- A dumping flap can discharge oily debris (wood, seaweed) or clean debris
- The top of the barge can be hinged open for:
 - Trash Collection (oiled booms/sorbents, shore sediments/debris bagged/unbagged)
 - Sized to optimize holding of Jumbo bulk bags
 - Cleaning
 - Equipment storage
- Enable oily water decanting/separation to allow water that settles below to be removed and discharged from the floating oil intended for disposal.
- Skids to facilitate dragging onto remote shores, in a river situation over gravel/rocks and for arctic conditions, ice and muskeg/wetlands
- Usable as equipment/supply storage container when not in service with provisions for resting on its side whereby the door/hatch swings open for direct entry to avoid having to reach/enter from the top
- Provisions for optimum stacking for storage and flat-deck truck and sea-container transportation.
- Catamaran configured to be pulled in tandem in currents/swells/waves (coastal and river) with positive tracking.
- Design to be used as temporary bridge pontoons using attachable girders/beams/connectors
- Long-lasting, tamper-proof GPS tracking informs its location and duration of the operation.
- A solar/battery system is built-in to supply power to navigational lights, a GPS location system, as well as enough power/capacity to run LED work lights/Davit/Winch as accessories
- Capability to attach a small outboard motor to be self-propel
- Avoiding protruding attachments that interfere with storage/stacking or are broken off/damaged.

Functionality from a Spill Standpoint

Operationally, small barges would be people extensive. However, from a Tier 1 local response capacity, they lend themselves to be used by common vessels of opportunity in a community – such as small 14+ foot fishing boats with a 35+ hp outboard motor (*e.g., Lund, Crestliner, Lowe, Lifetimer*). Factors are the seaworthiness and a bollard pull of the towing vessel relative to how far, fast, the number of *SZ Micro-barges* are loaded or unloaded, and the working environment (*e.g., protected coastal/arctic waters, up a river*).

SZ Micro-barge can be pre-loaded with booms, ropes, and anchors to implement *Geographic Response Strategies* (GRS). GRS are operational plans that tell responders where and how to protect a valued ecosystem (*e.g., cove, bay, estuary*) or facility (*e.g., marina, aquaculture*).

For shoreline cleanup, a workforce can drag an *SZ Micro-barge* onto shore and then be left to be filled with recovered oil or debris. They can be part of a shoreline deluge/flushing system whereby the oily water recovered by skimmers can be diverted to an *SZ Micro-barge* with decanting capability. This is provided by in-cargo piping.

An *SZ Micro-barge's* most salient function and objective is its capability to receive collected products such as oil at the source (*e.g., recovery vessels, manually within the shore zones or from shore treatments*) and then take it directly to final disposal, empty, and return to operations. There are no interruptions, no hatch opening, and no temporary storage until it reaches its final disposal destination. On-board GPS/Status electronic tracks over the sea and land an *SZ Micro-barge's* location; product on-board, unloading site and its return to service.

Inland rivers, wetlands/muskeg, and floating sea ice often call for temporary bridges over creeks, soft soils, and ice leads/polynyas. *SZ Micro-barges* can be configured to handle All Terrain Vehicles or pick-up trucks commonly used during an oil spill.

Linked *SZ Micro-barges* can serve as a dock for vessels when there is unsuitable bathymetry, either too shallow or too steep to accommodate safe shore access/egress of workers and their equipment.

Functionality from a Coastal Community Standpoint

A key design factor is to foster functionality and utility for a community. The audience can be an individual/business that sees value in an *SZ Micro-barge* purchase to support their commercial aquaculture or tourism business. It can be a government such as a First Nation's Band or Council that sees *SZ Micro-barges* serving their needs such as monitoring, harvesting and emergency preparedness. It could be a non-government organization engaged in coastal debris cleanup programs. A goal is to entice interest in purchasing an *SZ Micro-barge* for commercial/agency/NGO uses.

What is being strived for is “dispersed” assets where *SZ Micro-barge* locations are common and spread within and among communities. Each *SZ-Micro-barge* whereabouts and arrangements for emergency use are well established. This promotes a fast initial response as a Tier 1 local response, escalating as other resources arrive (Tier 2 – provincial/national, Tier 3 – international resources). The critical step is communicating with coastal communities to see how an *SZ Micro-barge* fits their needs to determine scale, design and features accordingly.

Market Opportunity

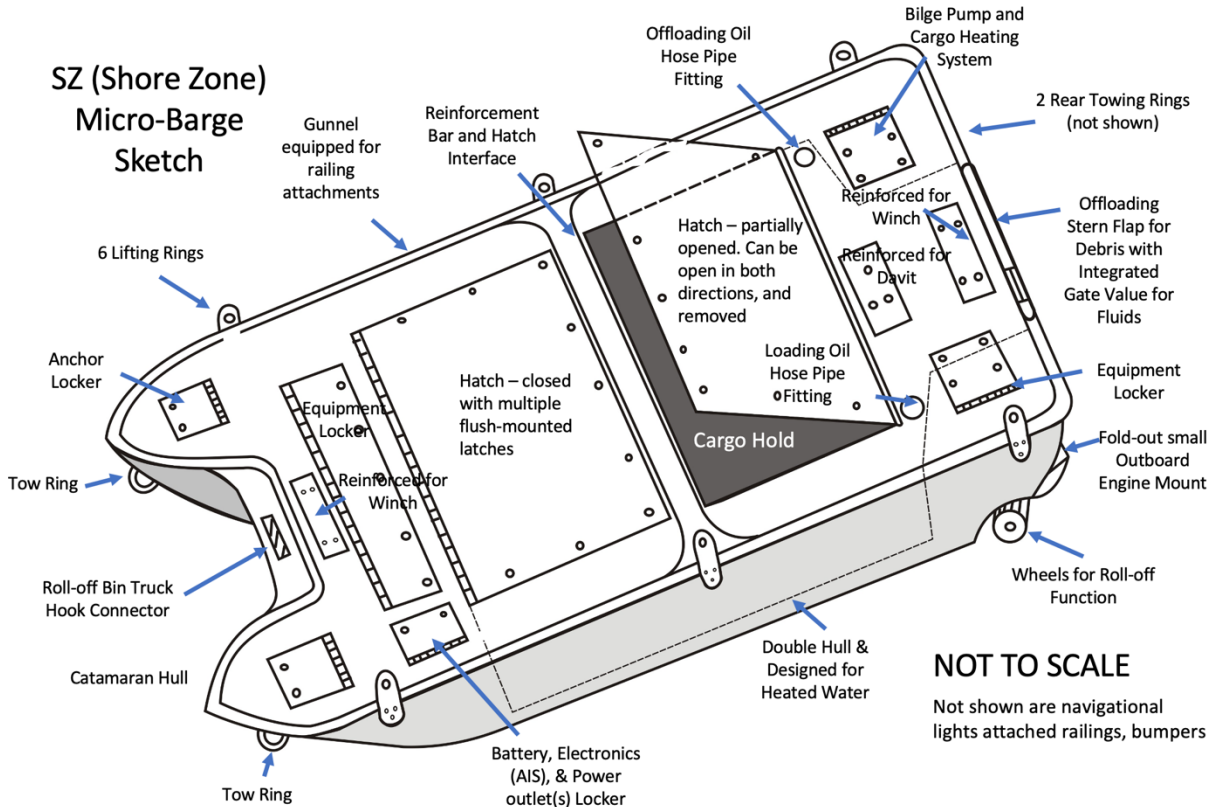
The concept explained above that fosters emergency preparedness and serves community needs has the potential to make *SZ Micro-barges* ubiquitous throughout a region and worldwide. They are capable of being self-marketing when others see their utility and flexibility.

There would be economies of scale for manufacturing as the number produced increases.

A market strategy is to subsidize purchases on the condition that they are made available during an incident and are always GPS-tracked to facilitate their locations and notifications.

APPENDICES

Appendix 1 - Preliminary Design & Specifications



Construction Materials: The *SZ Micro-barge* would be constructed from High-Density Polyethylene (HDPE). HDPE is a strong, firm, durable and robust material for marine purposes - particularly workboats. Moulding, extrusion methods, and 3-D printing can shape an HDPE boat/barge. The advantages of HDPE construction include the following:

- It doesn't corrode, oxidize or need waxing/painting, hence low maintenance
- No need for anti-fouling as algae don't grow on it
- Robust - almost indestructible - ideal for rocky shores operations can result in strikes and groundings
- Resistant to oils and chemicals, making cleaning and decontamination easy
- The service life of 50 or more years

Fixed Attachments: Marine Grade Stainless Steel

Lights: LED

Construction Method: Preferable 3D printed in one or two integrated components as hull and cargo components. Some smaller accessories are manufactured by *Computerized Numerical Control (CNC)*. The second option is hand-manufactured with welded components.

Basic Design: A barge with a slight catamaran hull for tracking with a flat bottom and doubled hulled construction around the cargo hold.

All the following dimensions and capacities are approximate.

Overall Barge Dimensions:

- 5.5 meters (18 feet) LOA
- 2.3 meters (7.5 feet) Wide
- 1.2 meters (4.0 feet) High

The *SZ Micro-barge* is sized to load four into a standard 12.20 m (40 ft) sea container with a 2.43 m (8 ft) width by 2.59 m (8.5 ft) height entrance door.

Cargo Hatch Opening and Application:

- 2.1 meters (7 feet) Length
- 1.5 meters (5 feet) wide

Hatches are sized to provide a 1.8 m (6 ft) bow and 1.2 m (4 ft) stern workspaces, 0.15 m (0.5-ft) walkway (gunnel) around the hatch opening, and a 0.3 m (1 ft) space/reinforcement crossbar in the middle of the hatch to secure doors.

Effective hatch cover size (2) for loading is 1.5 m (5 feet) by 1.0 m (3.5 feet). Hatches can be hinged fore and aft, as well as wholly removed with recessed D-rings to assist. This allows wastes/products to be put in from different directions.

Two hatches open and secured with attachable cross-braces increase cargo capacity for light debris or booms. Open hatches can be tarped with built-in strap holders on the gunnel.

Cargo Hold Dimension Volume & Capacity:

- *Dimensions:* 1.8 by 2.4 by 0.9 meters (6 by eight by 3 feet)
- *Total Volume:* 4 cubic meters (5 cubic yards)
- *Weight Capacity:* 4 tonnes (8,800 lbs)
- *Oil Capacity:* 4,000 litres (25 US barrels)

Hatch doors and cargo configured/sized to hold:

- Two stand-alone Intermediate bulk containers (IBCs) of 1000 litres 1.0 by 1.2 by 1.2 m (40 by 48 by 46 inches) or
- Four super-sacks/Jumbo bags 0.9 by 0.9 m (36 by 36 inches) tucked into a cargo hold or

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- Eight *Harbo Technologies Ultra-Fast Boom* Cartridges 0.6 by 0.4 by 1.0 m (24 by 16 by 40 inches) are tucked into the cargo hold (120 meters [400 feet] of the boom) with additional transport with cargo hatches opened.

Barge Weight:

Empty: Less than 2 tonnes (helicopter liftable)

Total: Less than 7 tonnes

Barge Draft:

- *Empty* 0.45 m (1.5 feet)
- *Full* 0.91 m (3.0 feet)

Core Features:

- *Towing* - singularly or in tandem by attachments bow and stern
- *Top Hatch* - that opens for large debris collection and can be fluid (oil, water) and then highly sealed/secured when closed and latched
- *Hose Connector* - for oil recovery systems while hatched is sealed and secured
- *Roll-off Capability:* A front hook connection and rear wheels for loading onto commercial bin-trucks
- *Lifting Features* - Corners and centre (6) are re-enforced loading attachments to raising for transported unloaded/loaded by flat-deck truck or singularly by helicopter
- *Emptying Capability:* Three means to empty cargo contents:
 - 1) Fluid oil - rear gate valve
 - 2) Debris - rear dump-flap
 - 3) Super sacks, debris, boom, equipment, etc. - top hatches
- *Double hull Construction:* the gap between the hull and cargo compartment
- *Oil Heating* - space created by double-hull and fitting enable a hot water/steam system to heat viscous, solidified oil to facilitate removal
- *Decanting:* using a mobile fluid piping system in the cargo hold with staggered depths.
- *Decontamination:* top-deck and gunnels designed for effective de-contaminated of the barge as well as any oiled response equipment with oily water entering the cargo's hold

Additional Features:

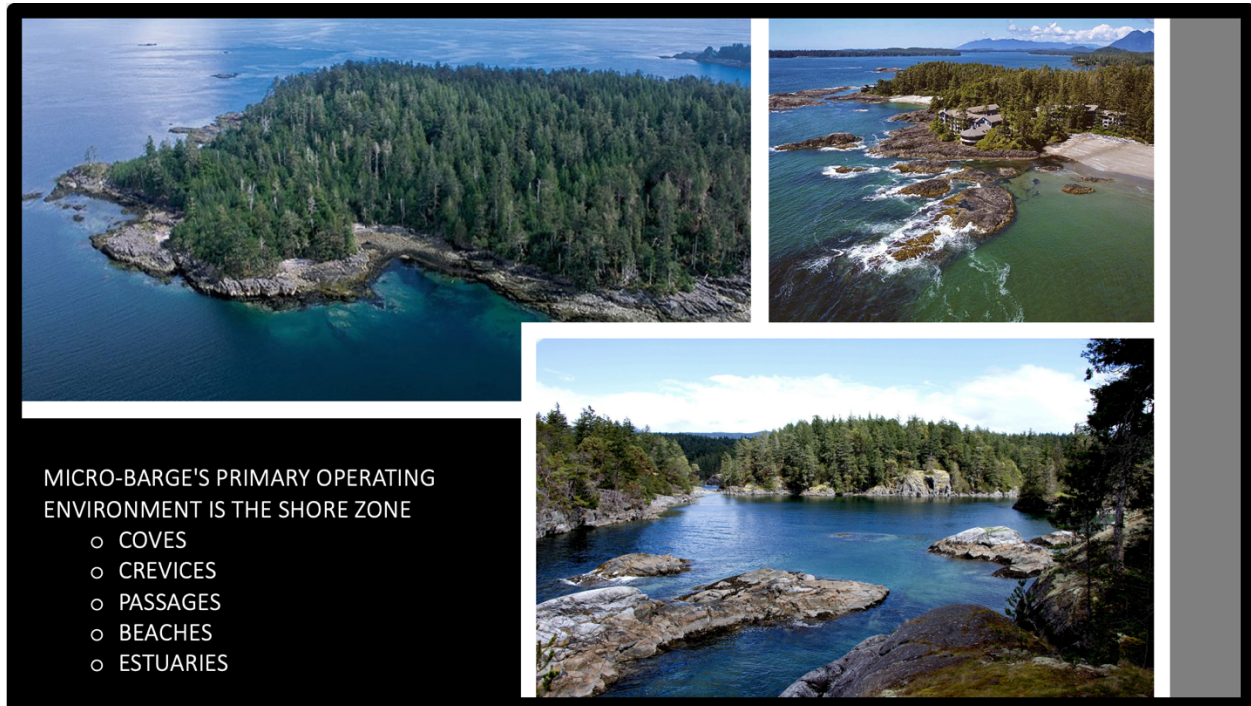
- Reinforce bottom skids for protection and wear from intentional beach grounding. Skids are sized and spaced to be part of a Roll-off bin system.
- Bow and stern configured:
 - As hinges to attach by inserted rods to connect barges as a bridge/dock, to allow for flexing and to reduce lateral movement.
 - For removable solid wheels used as bumper guards against strikes against rocks, walls, and crafts
 - Connecting standard ATV ramps

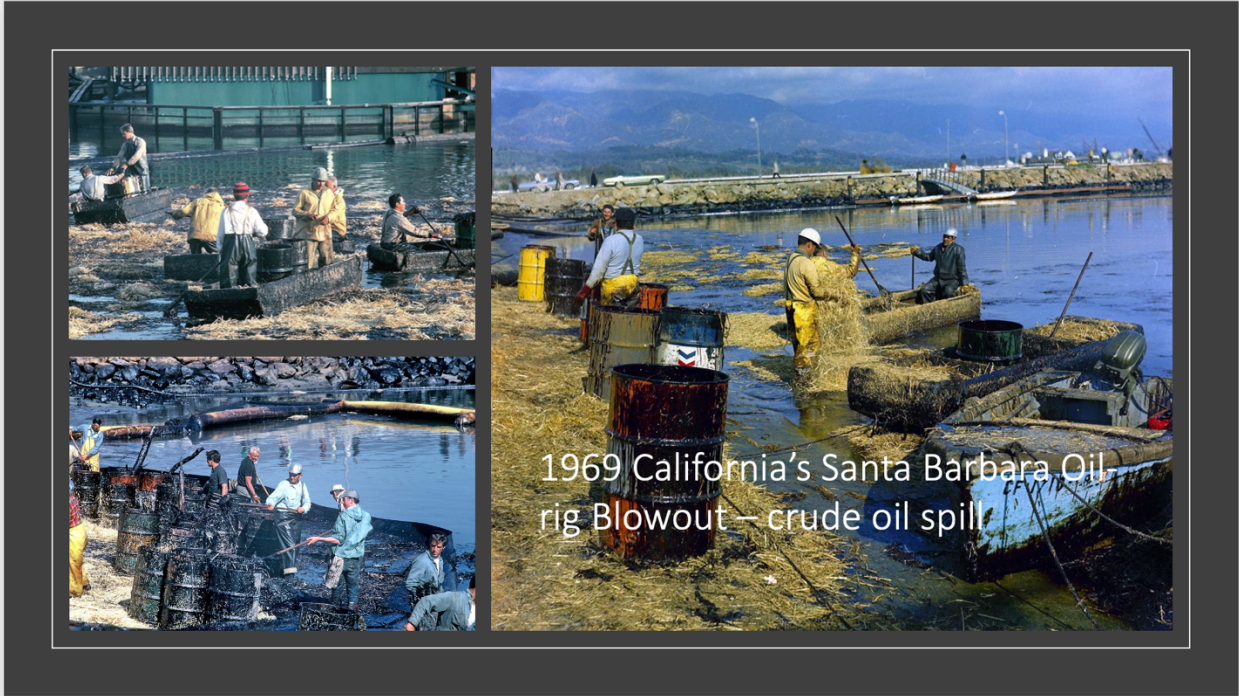
EnviroEmerg Consulting: Shore Zone (SZ Micro-barge) Concept

- Hatch cover can be left open and linked with bars to increase cargo storage.
- Deck-works flush to reduce worker tripping and rope snagging hazards
- Cargo and locker latches are opened/closed by a standard “bung” wrench used for drums
- Gunnel (gunwale) and deck to retain contaminated water and direct oily water to the cargo hold. Top-deck/cargo hold can be used to decontaminate other oiled equipment.
- Gunnel designed to facilitate hand-gripping
- Fitting holes into gunnel for attaching railings when used as a workspace or used for adjustable side-hull platforms to stand on when manually recovering product (oil or debris)
- Side-hull or gunnel attachments to attach nylon straps for holding to a small recovery work vessel or attaching a tarp over the open hatch - low force only
- Recessed water-sealed, hinged lockers:
 - In a bow to store tow cables, ropes, and attachments. Insert removable to access hull interior for inspections and hull through-put fittings (*e.g.*, tow rings)
 - In bow for electronics (GPS/AIS trackers) and battery with solar charging
 - In stern for gear
 - In stern for bilge-pump that is also equipped to provide heated water to de-solidify oil in the cargo hold
 - In stern for oil recovery hose connectors that capture and drain spillage back into the barge’s cargo hold and can be used to support a vacuum oil-recover system.
- Stern attachment for small outboard engine, with fold-down seat, crash-protection bar, and a top-deck mounting for the removable fuel tank.
- Navigational and working lights LED and self-dependent, rechargeable to eliminate wiring, flush and removable (integrated into hull/deck)
- Twelve-volt external plugs to connect corded LED working lights, bilge pump and operate optional Davit or ATV winch
- Loading attachments (6) used to install linkage bars to create a pontoon bridge or a dock for equipment transport
- Reinforce the location for a small removable capstan and ATV winch both fore and aft.
- Attention to oil decontamination by having sealed or self-draining holes, curved corners on deck and in the cargo hold, any decon-water directed to the cargo’s hold then removed *via* the stern’s discharge valve
- Side-hull markings to determine approximate cargo weights - calibrated for both fresh and marine water - and safety messages
- Special indented areas to guide and facilitate oil recovery hose, truck tie-down, and fork-lift loading, the meshing of stacked barges
- The micro-barge with its hatch bars, tarp, and lifting connectors can be put on its side to be used as a storage locker/shelter.

Appendix 2 - Image Gallery for Operational Context

The following images define the problem and working environments for a *SZ Micro-barge* to address.





2002 Spain's M/V Prestige Oil Tanker Spill

On-water oil recovery:

- o by large specialized offshore vessels: 20,000 tonnes
- o by small boats working nearshore: 30,000 tonnes







2021 California's Orange County Oil Spill
(Pipeline P00547 Incident)

2021



52 YEARS LATER THE ONLY CHANGES IN
NEARSHORE OIL RECOVERY IS BETTER
PERSONAL PROTECTIVE EQUIPMENT AND
USING PADS INSTEAD OF STRAW.

Still messy, inefficient, unsafe and
unhealthy to community responders

1969





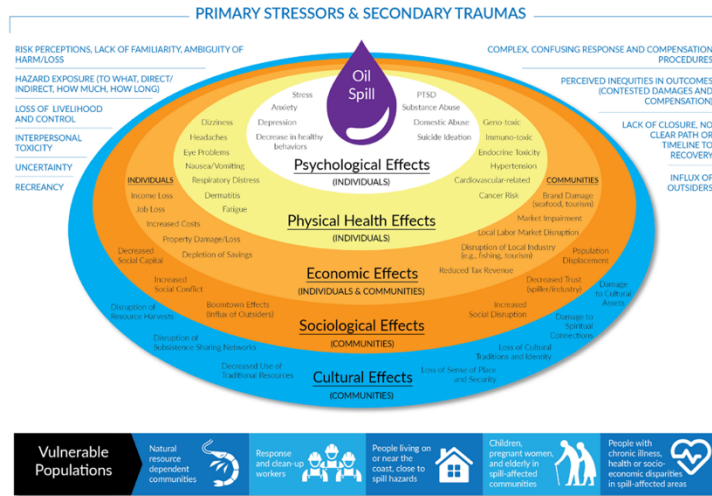
COMPARED TO CLEANING STRANDED OIL ON SHORES, THE RECOVERY OF FLOATING OIL IS CHEAPER WITH LOWER SECONDARY IMPACTS TO COASTAL ECOLOGIES AND ACTIVITIES, AS WELL AS TO RESPONDER'S HEALTH & SAFETY.

A micro-barge reflects the *Recovery Rule* whereby impact mitigation needs to be "as low as reasonable practicable" to reduce:

- Ecological impacts, and
- Response Costs

COMMUNITY AND HUMAN STRESSORS AND TRAUMAS FROM AN OIL SPILL

Not being prepared to recovery nearshore heavy oil or debris as depicted in the case studies is not just an operational deficiency; it could be another significant community and human stressor on top of all the others pertaining to a coastal spill - as shown in the graphic

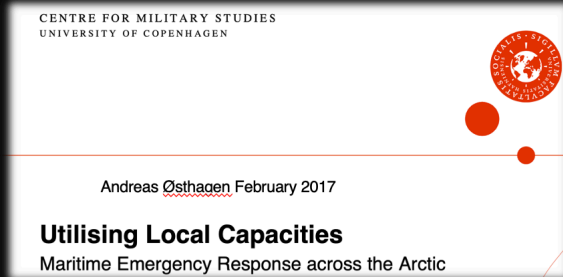


Graphic Source: Human Health and Socioeconomic Effects of the Deepwater Horizon Oil Spill in the Gulf of Mexico Paul A. Sandifer, Alesia Ferguson, Melissa L. Finucane, Melissa Partyka, Helena M. Solo-Gabriele, Ann Hayward Walker, Kateryna Wowk, Rex Caffey, David Yoskowitz

LOCAL RESPONSE CAPACITIES (Quotes)

Demands have been made for national governments to invest in and sustain relatively expensive Arctic capacities, such as coast guard vessels, long-range helicopters, and oil-spill response units. An often-overlooked dimension, however, are the local resources already in Arctic communities. This report suggests that a more efficient utilisation of local resources can reduce costs and save lives.

Distinction must be drawn between large-scale maritime incidents and closer-to-shore emergency situations. Community volunteers and mandatory training can go a long way to supporting the latter but have a limited impact on the former.



LEVERAGING LOCAL (TIER 1) RESPONSE PREPAREDNESS AND CAPACITY

Environmental emergency preparedness and its delivery can be from local to international levels by industries, agencies, and First Nations.

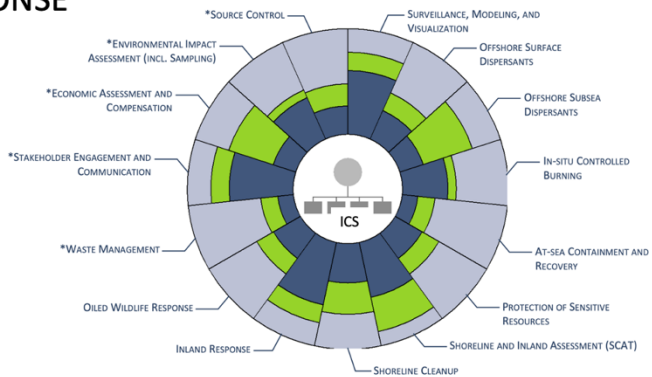
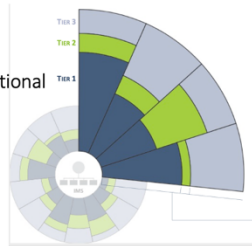
The list of capabilities are noted in the graphic.

Chart Legend:

Blue: Tier 1 Local

Green: Tier 2 Provincial/National

Grey: Tier 3 International



Note: The larger and longer /larger the graphical section, the greater the relevance of the activity/capability
ICS = Incident Command System to manage a marine incident

Strategy and Tactics

The response strategy and tactics would be to deploy a "swarm" approach to spill response using several vessels of opportunity in conjunction with micro-barges

Benefits of a "swarm approach"

- Allows for vessels to access several locations whereby booms need deployment or shoreline oil recovered.
- Reflects that there can be many vessel operators in a coastal community with small-boat skills and local navigational knowledge
- Supports mutual aid whereby several First Nations can contribute a familiar resource to a marine incident.



APPLICATION TO A CONTAINER VESSEL INCIDENT RESULTING IN COASTAL DEBRIS





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ARCTIC ENVIRONMENTS



STREAMS AND RIVERS

