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PROJECT SUBMISSION CHECKLIST

PART I - GENERAL CONTACT INFORMATION

1.1 CONTACT DETAILS OF ORGANIZATION

(only relevant if submitted by an institution/company/organization - individuals please complete 1.2)

Full Name of institution/ company/organization:	IntelliReefs		
Street and street number:	2618 Eastbourne Drive		
Postal code:	84121	Town:	Cottonwood Heights, UT
Country:	USA	Official homepage:	https://www.intellireefs.com/
Telephone: (including country code; no brackets or slashes)	+1 806 647 6072	Official company email: (i.e. info@examplecompany.com)	Science@intellireefs.com

1.2 INDIVIDUAL CONTACT DETAILS

Given name:	Melody	Family name:	Brenna
Academic title:		Gender: (please mark with x)	( ) Male / (X) Female
Street and street number:	1327 East Farmhill Dr.		
Postal code:	84117	Town:	Murray, UT
Country:	USA	Email (of contact person):	melody@reeflifefoundation.org
Telephone: (including country code; no brackets or slashes)	+1 806 647 6072	Mobile Phone: (including country code; no brackets or slashes)	+1 806 647 6072

PART II - PROJECT INFORMATION – OVERVIEW

2.1 GENERAL INFORMATION

Project title:	Creating Valuable Kelp Habitat Using Novel Customizable IntelliReefs		
Category: (please mark with x, choose only one category)	( ) Earth ( ) Fire ( ) Water ( ) Air ( ) Youth (X) Sustainable Start-Ups	Status of implementation: (please mark with x)	(X) Implemented project or ongoing project ( ) Planned ( ) Idea: only category Sustainable Start-Ups
Country of implementation: (choose only one)	Canada	Optional: additional countries of implementation:	

2.2 PROJECT SUMMARY

Please summarize (~10-15 lines,) what the project is about and what major outcomes have been achieved (please state concrete figures), especially any relevancy in regard to environmental protection, improvement of living and/or economic conditions, awareness creation, emission reduction, renewable energy, energy and resource efficiency, counteracting climate change, etc.; Please use a formal writing style as this summary will be published in our online database (use your/your organization's name in the text and do not use expressions like We, I, our company, etc.).

Like coral reefs are in tropical environments, kelp beds are vital marine ecosystems in temperate regions. Unfortunately, development of coastal areas in temperate regions of the world is threatening these valuable coastal ecosystems. However, altering artificial underwater structures to provide kelp habitat and building new habitat using artificial reefs can support the colonization of kelp and mitigate the impact of coastal development. IntelliReefs has developed Oceanite, a novel mineral aggregate material, as an alternative to concrete in the marine environment and has used this material to create effective coral reef habitat in tropical environments. Now, IntelliReefs has modified Oceanite to support colonization by kelp, and deployed a pilot study in an urban harbour in Canada to test the ability of Oceanite to foster the recruitment and growth of kelp and the development of their associated

communities. This project will provide the base knowledge necessary to launch Oceanite as a kelp substrate for numerous applications in temperate environments.

PART III – DETAILED PROJECT INFORMATION

Please provide **a complete and proper description at the jury's request**.

A) INITIAL SITUATION AND CONTEXT OF THE PROJECT/INITIATIVE

Please provide information (max half a page, 2000 characters) on the initial situation (problems, challenges) before the project was implemented. Depending on the type of project, please include the environmental, ecological, economic, social, energy or other relevant context of your country.

With over 40% of the world's population living in close proximity to the coast and global population continuing to rise, coastal areas and the marine life they support are increasingly subject to pressures associated with human development. Artificial marine structures (seawalls, jetties, breakwaters, etc.) are becoming prevalent along coastlines worldwide, and can have numerous negative ecological impacts, including habitat loss, reduction of biodiversity, inhibition of ecological connectivity, and promotion of invasive species. Other impacts associated with coastal development (e.g. pollution, sedimentation) can lead to additional habitat destruction and loss of biodiversity.

In temperate ecosystems, kelp beds are important coastal habitats that provide food and shelter to a diverse array of organisms, support commercial fisheries, bioremediate eutrophication, and can act as a carbon sink to combat climate change. However, kelp beds and the benefits they provide can be threatened by decreased water quality and habitat loss arising from coastal development.

Canada has numerous large urban centres located on its coasts, and has experienced the negative ecological consequences of coastal development in these areas. One such example is Halifax Harbour, an urbanized water body located in Halifax, Nova Scotia, on Canada's east coast. Marine ecosystems in the harbour, including kelp beds, have been damaged by pollution (e.g. raw sewage, which was discharged directly into the harbour until 2008), the construction of artificial marine structures, and other activities associated with urbanization in the city. Solutions are needed to help restore ecosystems in Halifax Harbour and other temperate urban water bodies like it.

B) DESCRIPTION OF PROJECT OBJECTIVE AND MOTIVATION

What was your overall motivation to start this project and what have been the project's objectives? (max half a page, 2000 characters)

Altering and replacing marine habitat can help combat the negative ecological impacts of coastal development. For example, the impacts of artificial marine structures on marine ecosystems can be addressed using ecological engineering, whereby the design of the artificial structures is modified to improve their integration into the ecosystem. Marine habitat lost due to coastal development can also be replaced with artificial reefs, which provide new structures for organisms to inhabit and can also function as coastal protection.

Concrete is the material most often used to create structures underwater, including artificial reefs; however, conventional concrete made with Portland cement has a highly alkaline pH and can leach trace metals, both of which can be harmful to marine organisms and deter them from associating with concrete structures. Additionally, concrete often lacks the topographical complexity and porosity necessary to facilitate the settlement of marine organisms. It is therefore important that effective alternatives to concrete are found as a hard substrate for use in artificial marine structures and artificial reefs.

IntelliReefs has developed Oceanite – a biocompatible, customizable mineral aggregate founded on nanotechnology – as an alternative to concrete in the marine environment, designed to promote the growth of organisms on its surface and integrate with the biological community. Featuring a pH identical to that of seawater, nano-encapsulation in the place of toxic binders, high porosity and surface complexity, and customizability of composition, it provides solutions to the ecological issues associated with concrete. Oceanite therefore an ideal material for use in the construction of artificial reefs or as a material for use in ecological engineering to promote biological growth on marine infrastructure. As shown by IntelliReefs' ongoing study in Sint Maarten, which received an Energy Globe Award in 2021, Oceanite is an effective substrate for recruiting coral and other associated organisms in tropical habitats. However, Oceanite has not yet been tested as a substrate for temperate organisms like kelp. Although rough, porous substrates like Oceanite are ideal for kelp, baseline data are needed to launch the use of Oceanite as a kelp substrate. IntelliReefs has therefore deployed a pilot artificial reef array in Halifax Harbour to test the ability of Oceanite to attract and foster healthy kelp communities.

C) SCOPE AND IMPLEMENTATION ACTIVITIES

Please describe in more detail (max half a page, 2000 characters) the scope of the project and the major activities that have been conducted for its implementation.

On November 21st, 2021, IntelliReefs deployed a pilot artificial reef array in Halifax Harbour in Nova Scotia, Canada. The reefs were deployed in Dartmouth Cove, a highly contaminated area of the harbour, to provide a proof of concept for the application of IntelliReefs to revitalize kelp habitat in degraded urban environments. The artificial reef array consists of 16 large (approx. 1 m^3) ReefShip modules composed of two mixes of Oceanite; one optimized for porosity and the other for strength. To compare the development of kelp communities on Oceanite with conventional construction materials, a control group of 3 concrete modules was deployed along with the Oceanite modules.

IntelliReefs, along with industry partner Dominion Diving, conducted the first round of scientific monitoring on the reef array in March 2022. Monitoring tasks included: 1) assessing the settlement and growth of kelp and other benthic organisms on the Oceanite and concrete modules over time using photo quadrats; 2) using video monitoring techniques to catalogue the community of motile fish and invertebrates associated with the modules; and 3) comparing the motile community and environmental DNA signatures of the reef site and a reference site within the Cove. IntelliReefs will continue conduct scientific monitoring overtime to build more empirical

data demonstrating the efficacy of Oceanite as a basis for kelp communities. This monitoring program will allow IntelliReefs to quantify the success of Oceanite in attracting and fostering a healthy kelp community in an urban setting, and to compare this community to the baseline state of the area where the reefs were deployed.

D) INNOVATION

Please describe the innovative aspects of your project under consideration of the technological standards and conditions (i.e. regional conditions, social conditions, economic conditions or political situation) of your country (max half a page, 2000 characters).

IntelliReefs secured $170,000 CAD through local and international funders for this project. This amount included design, manufacturing, and shipping costs for Oceanite blocks, research costs, travel expenses, and costs for ongoing scientific monitoring.

IntelliReefs' Oceanite is a novel mineral aggregate material bound together using high-performance nano-engineered concrete matrices. This gives Oceanite an open void structure with high porosity and rugosity, which facilitates the settlement and retention of marine organisms. The pH, chemistry, shape, strength, and texture of Oceanite can be customized for different marine substrate applications; for example, the minerals incorporated as aggregate in the reefs deployed in this project were selected to mimic the natural geology of Nova Scotia based on a prior geological survey, to optimize their ability to attract the settlement of kelp and other associated native organisms.

The majority of efforts to create kelp habitat (e.g. artificial reefs) in temperate regions to date have used various forms of concrete. For example, a past project in Halifax Harbour installed artificial reefs made of textured, pH-neutral concrete. However, concrete has limited flexibility in terms of its composition and physical properties; for example, it must be impervious to water to retain its strength. In contrast, Oceanite has a porous structure, facilitating the settlement of marine organisms within these pores while retaining its structural integrity. Additionally, concrete lacks the fine-scale customizability that allows Oceanite to be tailored in terms of pH, chemistry, and topography to fit a given application, such as attracting the settlement and facilitating the attachment of a specific target organism (e.g. kelp). Oceanite therefore represents a substantial improvement over even enhanced concretes as a substrate for marine organisms.

E) IMPLEMENTATION AND COSTS

- For projects including a **technological component**: Please describe the technology applied, as well as the costs and economic benefits (max half a page).
- For projects including a **social component**: Please describe the approach that you have chosen as well as the social impact of your measures had on which target groups. (max half a page, 2000 characters).

IntelliReefs secured $170,000 CAD through local and international funders for this project. This amount included design, manufacturing, and shipping costs for Oceanite blocks, research costs, travel expenses, and costs for ongoing scientific monitoring.

Kelp beds provide valuable ecosystem services for humans, such as supporting fisheries, absorbing nutrients like nitrogen and phosphorus to remediate eutrophication, and absorbing carbon dioxide to fight climate change. Given that kelps of the genus *Laminaria* provide ecosystem services worth an estimated $222,000 USD per hectare per year, even IntelliReefs' pilot project will contribute significant economic value to Halifax Harbour, as kelps covering the entire surfaces would be worth approximately $1300 USD per year. When scaled up (see section G) using the results of this study, IntelliReefs will be able to implement projects generating considerable economic purely from the ecosystem services provided by kelps grown on Oceanite.

F) DESCRIPTION OF ACHIEVED RESULTS

Please describe in detail all direct and indirect results. Depending on your project, please focus especially on environmental and/or social and/or economic impacts resulting from the implementation of your initiative. Where possible, please include figures (i.e. number of people trained or jobs created, tons of CO^2 avoided, m^3 of water treated, MWh of renewable energy provided, energy efficiency before/after renovation, tons of waste collected/reduced, number of trees planted, etc.) or descriptions on how people or environment have otherwise benefitted from your project (max half a page, 2000 characters).

Only 4 months after deployment, Oceanite has already proven effective in recruiting kelp and its associated community, with up to 70% coverage by marine plants and animals. Preliminary video surveys in March 2022 have found rapid colonization by juvenile kelps, along with numerous other plant and animal species associated with kelp and rocky bottom habitats, including sculpin, starfish, hermit crabs, juvenile fishes, and filamentous algae. In addition to its proven benefits in tropical areas, these observations demonstrate the effectiveness of Oceanite's high surface complexity in rapidly creating biogenic habitat supporting a vibrant and diverse associated community in temperate regions.

In contrast to the Oceanite reefs, concrete control reefs were mostly barren, with only small patches of filamentous algae (~5% coverage). This is likely a result of low surface complexity and the hostile chemical environment (high alkalinity, metal leaching) of the concrete. The concrete reefs were deployed within 10 m of the Oceanite modules, demonstrating the stark difference in biological colonization between Oceanite and concrete in an identical environment.

Substantially more species were observed at the reef site compared to the reference site (a representation of conditions at the artificial reef site prior to reef deployment), where only starfish and some juvenile fishes (both also observed at the artificial reef site) were captured on video. The large difference in species richness between the two sites highlights the ability of Oceanite to attract a healthy, novel biological community, even in urban areas like Halifax Harbour that have been degraded by pollution and coastal development.

Over the coming weeks, IntelliReefs plans to conduct a quantitative survey of the biological communities at the artificial reef and reference sites, to gain further insight into the above trends. More such surveys will continue to be conducted to monitor the reefs in the long-term. Based on observations to date, it is anticipated that future monitoring rounds will show continued development of a diverse and healthy kelp community on the Oceanite modules, while a depauperate community will be present on the concrete control reefs and at the reference site.

G) REPLICATION POTENTIAL (MODEL CHARACTER)
Please describe the replication potential of your project in other regions or countries (max half a page, 2000 characters).

Data on the properties of Oceanite as a kelp substrate resulting from this Canadian pilot study will launch the use of Oceanite for the provision of kelp habitat throughout temperate regions of the world where kelp is an important habitat forming organism. There are numerous potential applications of Oceanite as a kelp substrate. For one, retrofitting existing concrete infrastructure with Oceanite panels could increase its ability to foster the growth of kelp and help develop kelp communities on developed coastlines, increasing biodiversity and ecological connectivity in these areas. Kelp can also attenuate wave action, and therefore Oceanite could be used to create kelp-based living seawalls and breakwaters with better wave attenuation performance than conventional structures. Oceanite artificial reefs could also be used to rebuild kelp populations in the wake of disturbances like coastal development. As kelp has the potential to sequester large amounts of carbon, Oceanite could also be used as substrate to grow kelp for carbon sequestration to fight climate change. Given its highly customizable nature, the chemical and physical properties of Oceanite could be fine-tuned to fit the requirements of any of these applications. Depending on the project, Oceanite modules could either be used to attract natural kelp settlement or could be pre-seeded with kelp spores to rapidly deliver kelp habitat to areas where it is needed. Overall, the myriad potential applications for Oceanite as a kelp substrate underscore the importance of this pilot study.

PART IV – PHOTOS AND PROJECT DOCUMENTATION

Please send 4-6 photos in print quality (~400 kb – 3 MB per picture) which document your project well. Preferred file format .jpg or .gif
You can also upload additional project material.
Upload these materials as part of your online-submission on www.energyglobe.info/participation/

PART V – FINAL INFORMATION AND AGREEMENTS

5.1 HOW DID YOU HEAR ABOUT THE ENERGY GLOBE AWARD?
Please mark all answers that apply with x.

( ) Mail by Energy Globe	( ) Print media	(X) Friends/Colleagues
( ) Call by Energy Globe	( ) Facebook	( ) Google
( ) Internet	( ) Radio/TV	( ) Conferences/Fairs
( ) Contact by Energy Globe Ambassador		( ) Other

5.2 SUPPORT BY ENERGY GLOBE PARTNER
In the future there is a possibility that selected projects with exceptional prospects are supported by an ENERGY GLOBE Partner on their way towards marketability with management, sales and distribution know-how, as well as financially. If you are interested in this possibility, please mark the yes field with x.

(X) Yes / ( ) No

5.3 STATEMENT OF AGREEMENT (ACCEPTANCE IS OBLIGATORY for submission)
By participation in the ENERGY GLOBE Award competition I agree to the electronic processing, sharing within the ENERGY GLOBE partner network and publication of my project.
I herewith declare, that my statements regarding the submitted project are complete and correct and may in part or in total be published by Energy Globe. Energy Globe shall not be liable for the correctness and completeness of these statements. In case of any law suits or litigation, e.g. regarding copyright or publishing right, the submitter is responsible that Energy Globe shall not be involved in any such law suits or litigations. The submitter shall in any case completely indemnify Energy Globe against all effects resulting from such law suits or litigations. By marking the yes field with x, I confirm agreement with this declaration and the resulting legal consequences (Acceptance is required for submission). Please mark the corresponding field with x.

(X) Yes / ( ) No

Thank you for completing the required information.
We kindly ask you to submit your project information online on www.energyglobe.info/participation/

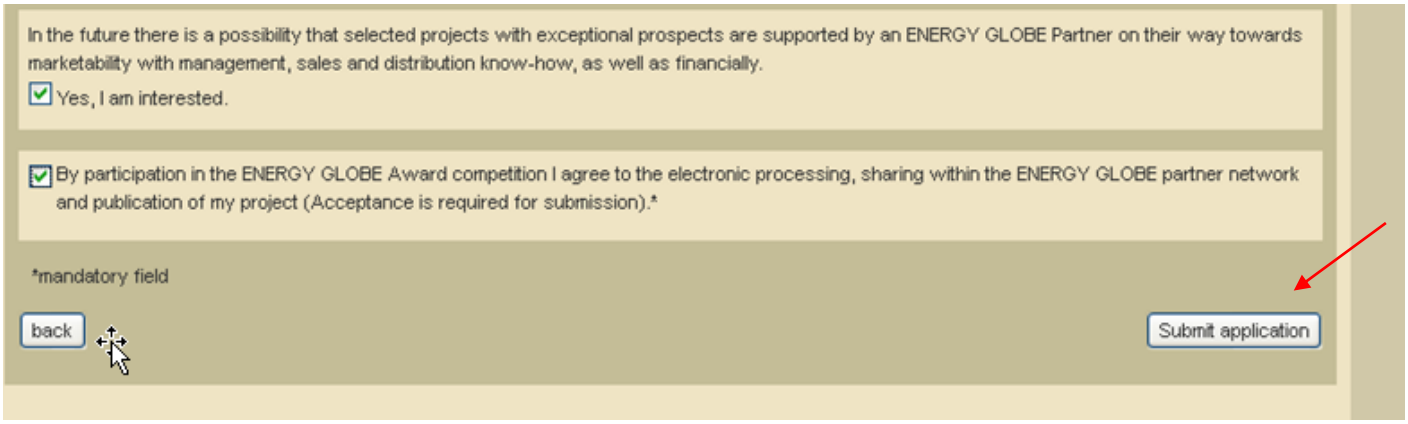
For organizational reasons please do not send this file via email. You can simply copy/paste the entered information with Ctrl-C/Ctrl-V into the online form. Thank you for your support.

After submitting your project online, **please check whether we have received it successfully!**

1. Fill in all required texts and upload all documents and click at the **"Submit application"- Button.** (Please see screenshot below)
   We do not receive your texts and documents until you click on this button.

2. Check your Email-Inbox if you have received an email-confirmation at the email address provided. (also check your Spamfile).
   Subject of this email: Your project application has been successfully received (ID: AWD0000)

3. Email us at contact@energyglobe.info in case you do not receive the confirmation email.



Categories:

EARTH:
Projects relating to agriculture, crops employable for energy, building materials, insulation, solar energy and overall energy efficient construction

FIRE:
Projects relating to energy production, the efficient and sustainable use of energy in all fields of application

WATER:
Projects relating to the use and processing of drinking water, waste water management as well as the preservation of water reserves

AIR:
Projects relating to air pollution management – indoor and outdoor – improving air quality, overall climate protection and the reduction of CO2

YOUTH:
All sustainable projects to or implemented in conjunction with young people to improve environmental awareness

SUSTAINABLE START-UPS:

The twin challenges of reaching net zero targets and meeting SDGS targets requires society to urgently develop and scale-up transformative innovations. As such, innovation will play a key and central role in realizing the required rapid, far-reaching and unprecedented change that spans across sub-systems and thematic categories, including cities, food, energy, materials, industries, finance. Sustainable start-ups are transforming the ingenuity and creativity of innovators and entrepreneurs into businesses that provide environmental solutions but also create new green jobs and enterprises. This new category of the Energy Globe seeks to recognize start-ups in developing and emerging economies that have developed innovations that have transformative environmental benefits but also create new economic opportunities.