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A tethered, self steering wing that optimises marine biomass growth by raising and lowering using ocean currents.

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ABSTRACT

(0006] The invention envisions a scalable solution for large scale commercial kelp production and climate restoration using an autonomous depth cycling tethered wing and sub tethered kelp array.
(0007] The invention taps into the unlimited renewable energy of ocean currents like the East Australian Current(EAC) to guide a kelp array from the sea surface where sunlight is abundant, to depths below the thermocline where cool nutrient rich waters stimulate nocturnal growth.
(0009) The unique proposition of this invention involves tethering winged devices at depths of 2-300m in places like along the edge of the Australian continental shelf.

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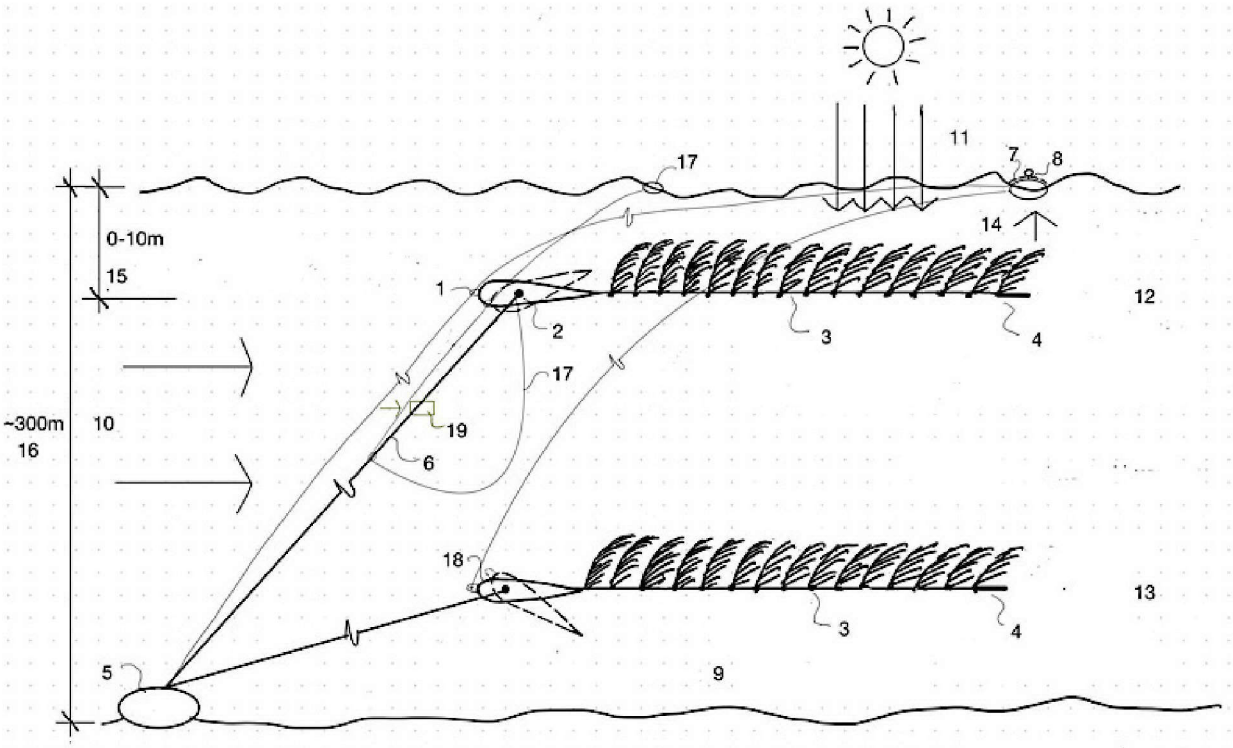


Figure 1

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FIELD OF THE INVENTION
Ocean biomass growth

BACKGROUND

[0001]Kelp is the fastest growing carbon dioxide drawdown species on the planet
[0002]Giant kelp(Macrocystis pyrifera) is disappearing at an alarming rate in many coastal regions around the world. This has occurred due to ocean warming, loss of nutrients, over harvesting, sea urchins and other environmental factors. For example, 95% of the giant kelp has disappeared from Tasmania's east coast over the past decades. Other species of kelp such as Golden Kelp(Elklonia Radiata) is also threatened by warming waters and depletion of nutrients.)
[0003] Nutrients and cool water exist in the deep ocean (>100m depth) that can stimulate growth of kelp and other marine organisms.
[0004] Ocean currents exist like the East Australian Current(EAC) which flow at up to 7m/sec in summer.
[0005] Sometimes surface and deep currents flow in different directions.
If this is the case, the apparatus will rotate around its mooring to capture the current's energy to steer the apparatus up and down within the water column.

RELATED ART

[0010] Alternatives include methods to pump up deep ocean nutrients to bio stimulate kelp and other seaweeds. This approach requires a more intensive maintenance regime due to the number of components that can fail, a higher capital cost and a large number of solar panels to power pumping due to the large head of water required to be lifted.
[0011] Other systems are also more vulnerable to exposure of the floating solar platform which needs to be transported to a refuge in the event of a cyclone.
[0012] The proposed invention will be an improvement over current methods ocean biomass growing methods in terms of reliability of constant ocean current flows. The non motorised and non powered method proposed to raise and lower the apparatus, will have greater weather security and consequential protection of the growth medium, greater simplicity of the technology, lower cost and a lower maintenance regime.
[0013] An alternative called the Marine Bioenergy Kelp Farm https://www.marinebiomass.com/ envisages submersible drones which travel near the ocean surface during the day and then dive to 80m at night. https://youtu.be/x1Occz_DwCk .
The advantage of the proposed invention over this system is that when tethered in strong ocean currents, it does not require mechanically powered drones to tow the kelp array. The proposed invention does not require any electronics, renewable energy or motors except a surface buoy which has a small solar powered battery for a beacon and AIS navigation transmitter.
[0014] Apart from being far less expensive to fabricate and operate, the proposed invention is also easier to control, harvest and maintain as they will be tethered along continental shelves close to mainland ports. The Marine BioEnergy concept is proposed to be untethered in the open ocean where they could become a navigational hazard and more likely to be lost or washed up on coastlines.
[0015] Given the remote offshore locations for the invention, it is important that it be as low maintenance as possible to be feasible long term.

BRIEF DESCRIPTION OF DRAWINGS

[0016] Figure 1 is a schematic section of the steering apparatus and kelp array, according to an embodiment.
[0017] Figure 2 is a schematic plan view of the steering apparatus and kelp array, according to an embodiment.

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[0018] Figure 3 shows the apparatus in different configurations(surface, transition,deep), according to an embodiment.
[0019] Figure 4 is a detail of the non electronic ratchet spring timer according to an embodiment.
[0020] Figure 5 is an isometric illustration of the apparatus, according to an embodiment.
[0021] Figure 6 is a map of potential deployment of the invention in the EAC along Australia's continental shelf.
[0022] Figure 7 is the vision for a Great Australian Marine Biolink where this invention could be located at scale for biomass regeneration, seaweed and other aquaculture production.

DETAILED DESCRIPTION

[0024] The invention consists of a large autonomous steering wing and sub tethered kelp array.
[0025] The kelp array consists of seeded kelp ropes in a large rectangular grid that is towed downstream of the steering blade.
[0026] The kelp array is held apart by the tail edge of the steering blade and and separate thin stern blade.
[0027] The kelp grows up towards the sunlight using their holdfasts to secure to the rope array.
[0028] Other sealife including other harvestable seaweeds endemic and acclimatised to local waters, bivalves will also be induced to grow on the array.
[0029] Harvesting of the kelp and other aquaculture will be carried out by raising the array to the surface. Harvesting of kelp will be processed for food, feed, fertiliser and biofuels.
It should be noted that 20-25% of harvested seaweed sinks to the deep seafloor and is sequestered for 100s of years before returning as carbon to the surface.
[0030] The wing will be made of carbon fibre, treated wood or similar strong material with positive buoyancy by either a hollow core or buoyant core material such as foam glass or polystyrene. Ropes could be manufactured from kelp or other natural materials.
[0031] Being a long beam structure, the wing will be inherently strong for both primary tethering, array sub tethering and the withstand strong currents and wave action.
[0032] The wing and array will be positioned at a nom. depth of 10-20 metres during the day for maximum UV growth.
[0033] Being positioned at ~10-20m depth will protect the device from usual wave action, storms and most vessel movements over the apparatus.
[0034] Flexible marine solar modules with battery backup will be mounted on a sub tethered buoy to communicate AIS location and navigation beacon.
[0035] The sub tethered buoy may also be used for wind power generation with wind turbine/s mounted on the top of the buoy. Wind power could be used for marine cloud brightening(MCB) using salt aerosol and/or ocean microbubble generation of seawater to increase cloud and/or ocean reflectivity.
[0036] At night, the array will be steered to a depth where it will absorb rich nutrients and ocean coolth before returning to near the surface during the daytime. This process mimics the natural process which occurs in the ocean every night when fish and other sea life migrate to the bottom of the water column and return during the day.
[0037] The depth below the sea surface will be controlled by the floatation capacity of the sub tethered buoy. When the apparatus approaches the desired depth, a line from the buoy connected to the front of the steering wing tilts the apparatus to steer the wing parallel to the seafloor until predawn when the device is timed to steer back up to the sea surface at an angle of 45°.
[0038] When the apparatus rises to 10-20m depth, a separate line from the mooring to the front of the steering wing tilts the apparatus back to 0° to steer the device parallel to the sea surface until circa sunset when the device is timed to tilt down at 45° to steer back to the seafloor.
[0039] The time that the apparatus will steer parallel to the sea surface and desired depth will be controlled by non electronic timers which are mounted at both ends of the wing.
The time in different positions can be adjusted to suit changes ocean current throughout the year.
[0040] By controlling the depth to keep the device suspended in the water column, predators like sea urchins will be less likely to be able to feed on the kelp.
[0041] Triangulated mooring lines from the wing will be joined to a single mooring line to the seafloor.

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[0042] The primary tethering mechanism involves a tension mooring line and mass mooring (eco mooring) which minimises damage from dragging mooring lines on the sea floor.
[00443] Retrieval of the device will be via the sub tethered buoy. Its position will also always be available by AIS.
[0044] The device can be readily retrieved when close to the surface by a rope and pulley system with a normal cleat or lockable jamb cleat on the front of the steering wing.
[0045] The apparatus will have a small positive buoyancy by a combination of the floatation of the wing and buoyant kelp bladders.
[0046] The self steering wing is surrounded by natural open cell sponge or similar material which soaks up rich nutrients at night at depth and slowly disperses them to the kelp array and surrounding waters during the day. This will further promote growth of local biomass in the form of healthy phytoplankton blooms.
[0047] Depending on the temperature of the water, weather conditions and solar flux, the invention can be set at the optimum depth to promote growth and protect the device.
[0048] Although faster ocean currents will drive the apparatus more rapidly, eg. 5m/sec in the EAC, slower currents down to 2-3m/sec will still drive the device but depth transitions will take longer.
[0049] Untethered options are also possible using a motorised propeller mounted at the front of the apparatus. The motorised propeller/microturbine generator would be automated to maintain constant depth or tilt up and down to steer the wing down or up from the bottom of the ocean.
[0050] Instead of a wing, the apparatus could also be a guided circular, oval or rectangular shape, either tethered or untethered. These shapes would increase the area of towed array.
[0051] One of the benefits of the submerged apparatus is that can grow different species of kelp and other seaweeds in locations where warming waters would otherwise suppress growth. This is due to the fact that it can be positioned below excessively warm surface waters. The proviso is that species are endemic to the local marine environment.

DRAWING LEGEND

1. Self steering wing
2. Foiling device/graduated ratchet timer(0°, +45°,-45°), triangulated stabilisation bracket
3. Kelp array
4. Stern separation blade
5. Eco mass mooring
6. Mooring line
7. Solar panels
8. AIS/solar buoy
9. Deep ocean nutrients
10. Ocean current
11. Solar radiation
12. Day location of apparatus
13. Night apparatus location of apparatus
14. Array guided to surface for harvesting
15. Variable depth depending on storms, navigation risks, harvesting, maintenance and solar flux
16. Depth for deep ocean nutrients
17. Jamb cleat release to allow surfacing of apparatus
18. Natural open cell sponge
19. Microturbine generator(tethered version only)
20. Nom. 20m
21. Nom. 50m

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CLAIMS

1. A method comprising: an apparatus to control the depth of a growing ocean biomass array with a self steering tethered wing.

2. The method of claim 1, wherein the apparatus uses ocean currents to achieve depth control - shallow during the day for surface sunlight and deep at night for deep ocean nutrient and coolth enrichment.

3. The method of claim 2, wherein the apparatus achieves claims 1 and 2 without any form of motorised, renewable energy or electronic operations which are more subject to failure when submerged or at depth.

4. The method of claim 3, wherein depth of the apparatus is controlled by non electronic ratchet timers, triangulated brackets, ropes, mooring and surface buoy.

5. The method of claim 4, wherein the apparatus encourages abundant growth of kelp or other harvestable seaweeds, bivalves and other sea life by enabling provision of both ocean surface sunlight and deep ocean nutrients to be optimised.

6. The method of claim 5, wherein the apparatus avoids predation by sea urchins and other seafloor marine life by remaining suspended in the ocean water column.

7. The method of claim 6, wherein the apparatus has an open cell sponge surround to the self steering wing which will soak up nutrients from the deep ocean at night and release them during the day.

8. The method of claim 7, wherein the seaweed and other marine organisms growing on the apparatus absorb nutrients for their own biological needs and also carry further life giving nutrients to the ocean's surface for partial release during the day.

9. The method of claim 8, wherein the apparatus can be deployed on the edge of continental shelves, seamounts, sea ridges up to 500meters depth and all locations where there is adequate ocean current flows, deep nutrients and seaweed species grown and harvested are endemic to the location.

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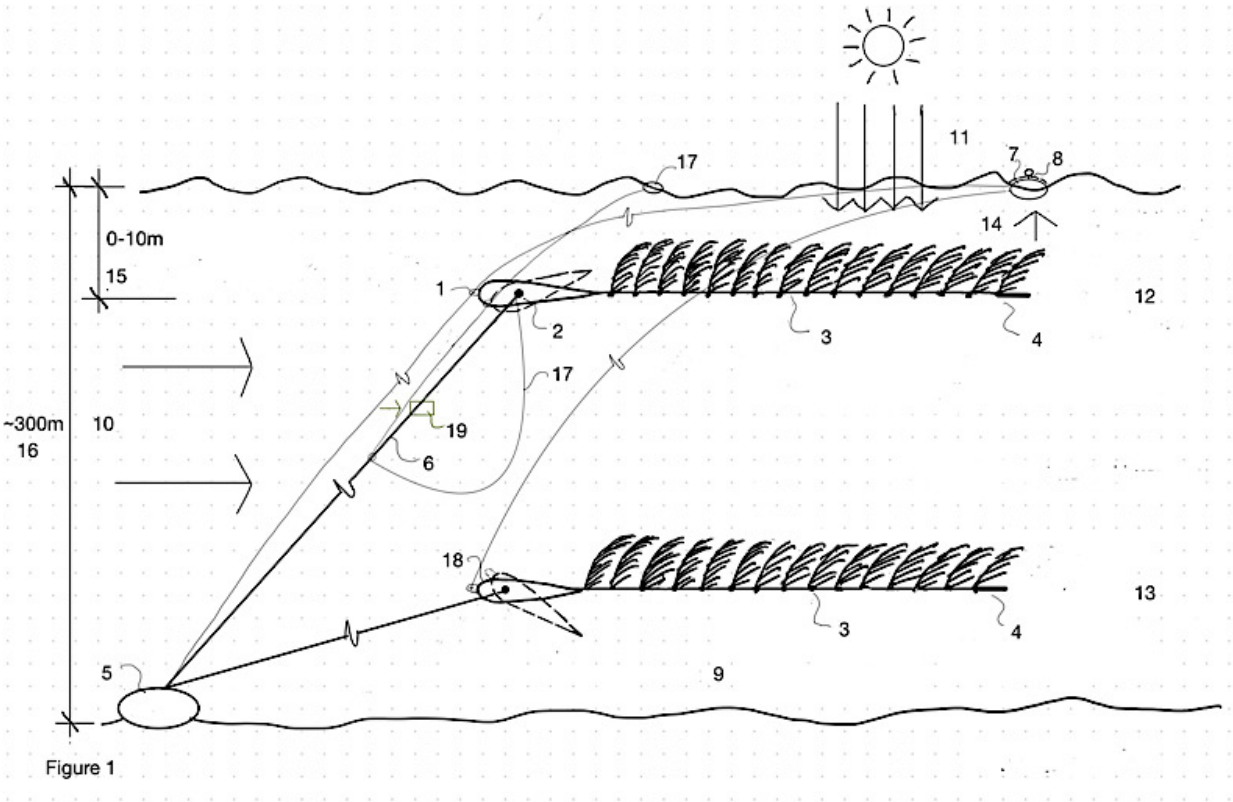


Figure 1

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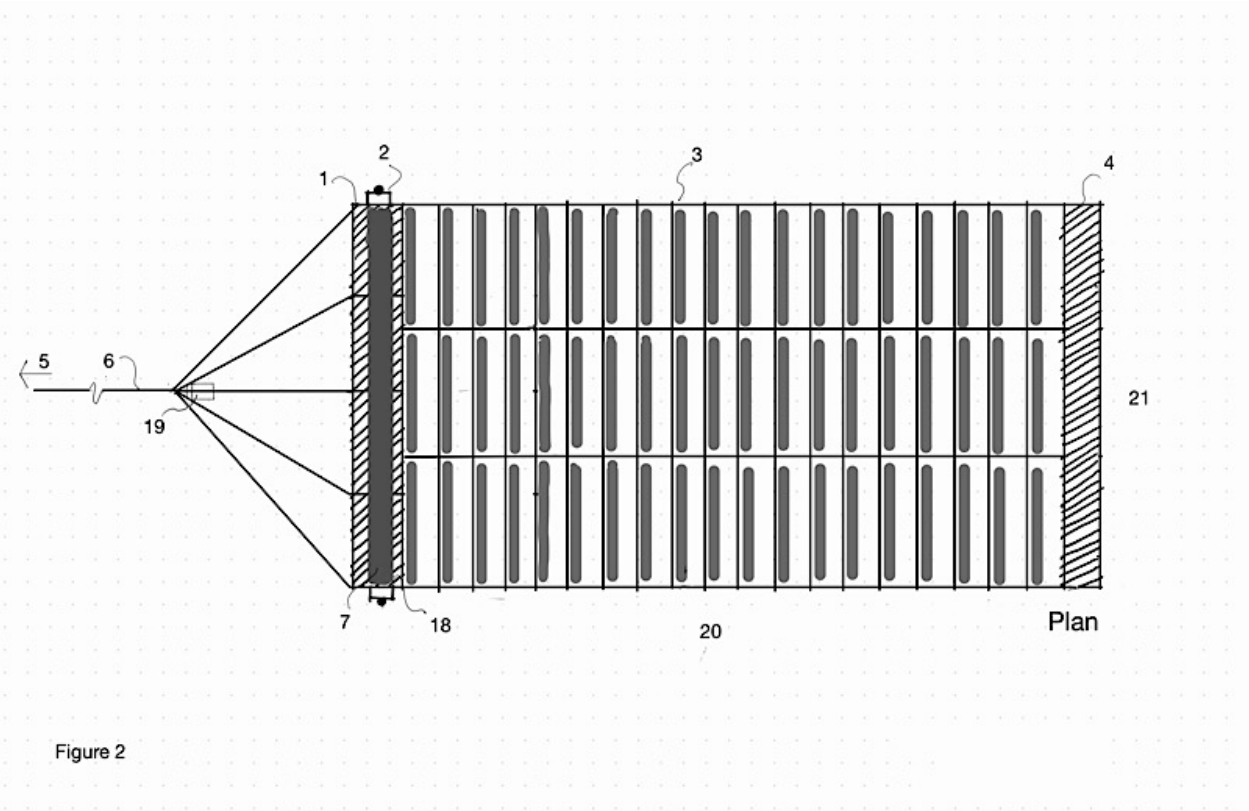


Figure 2

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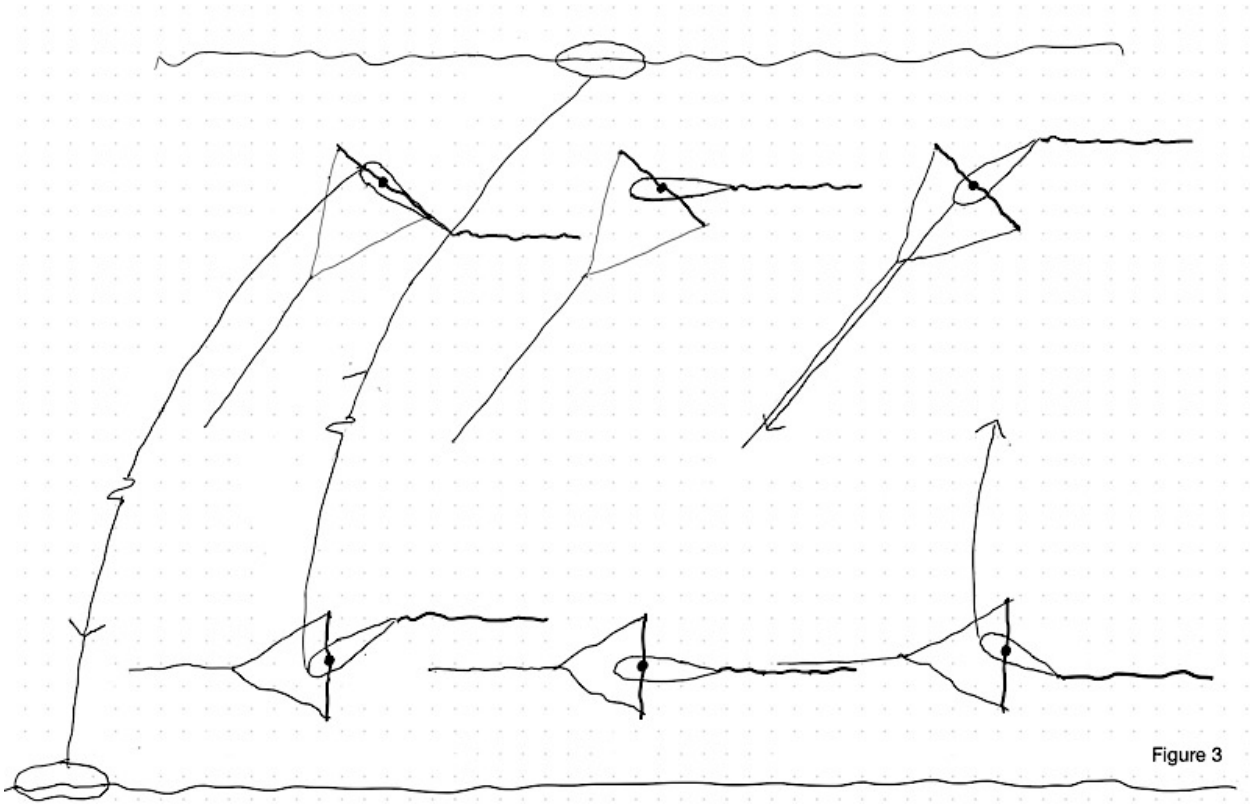


Figure 3

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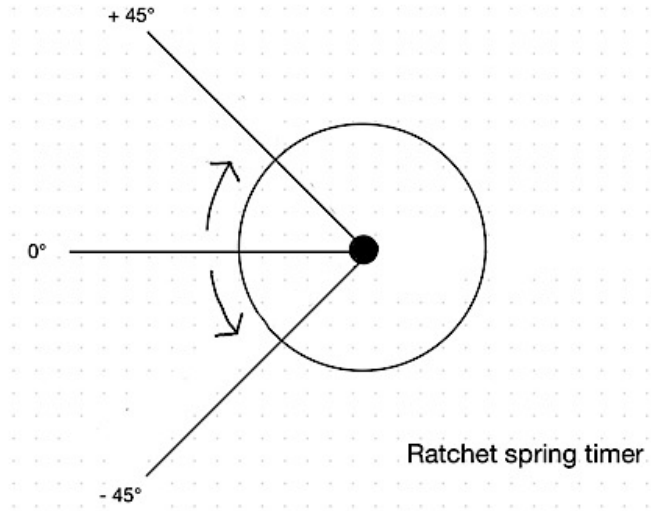


Figure 4

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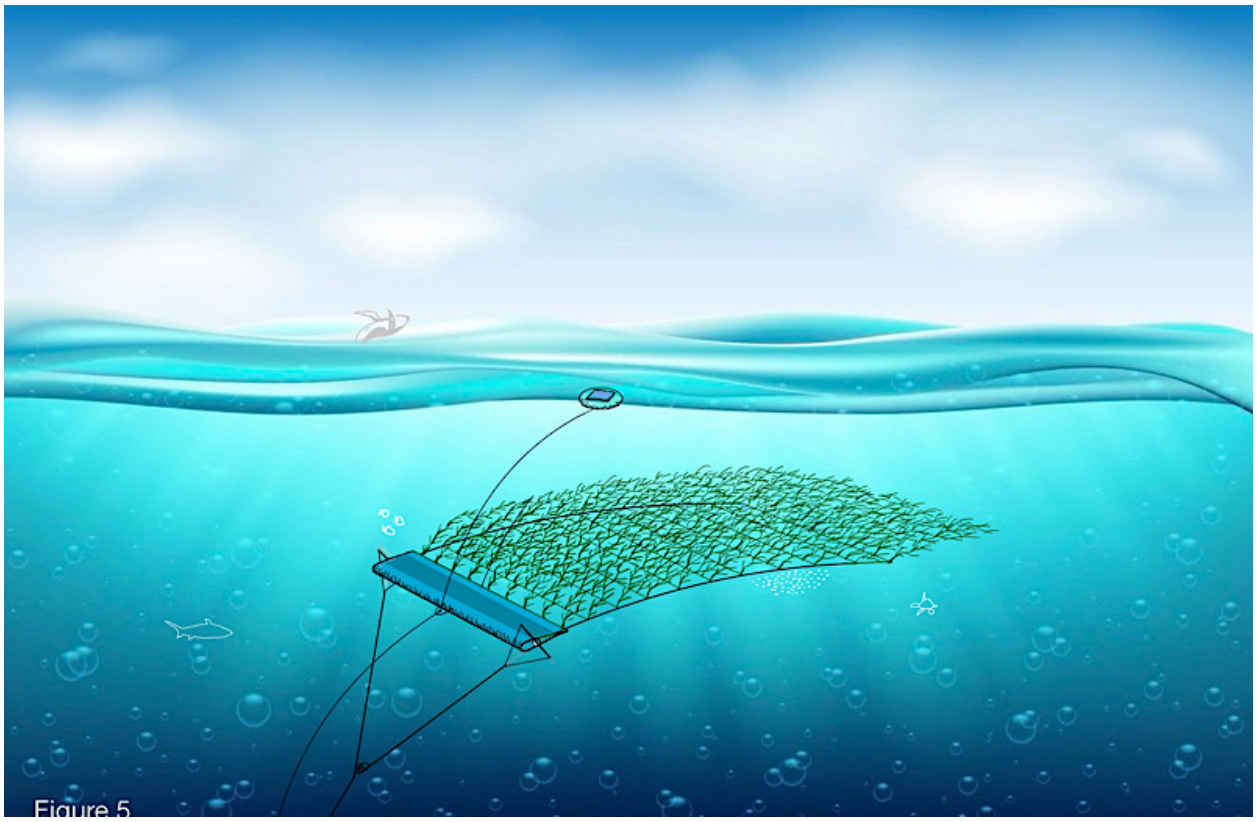


Figure 5


Yea
Omeo
Bombala
Melbourne
Bairnsdale
Orbost
Sale
50
Tasman Sea
Bass Strait
Nine Mile Beach
50
Blackback
Burnie
Waratah
Launceston
Longford

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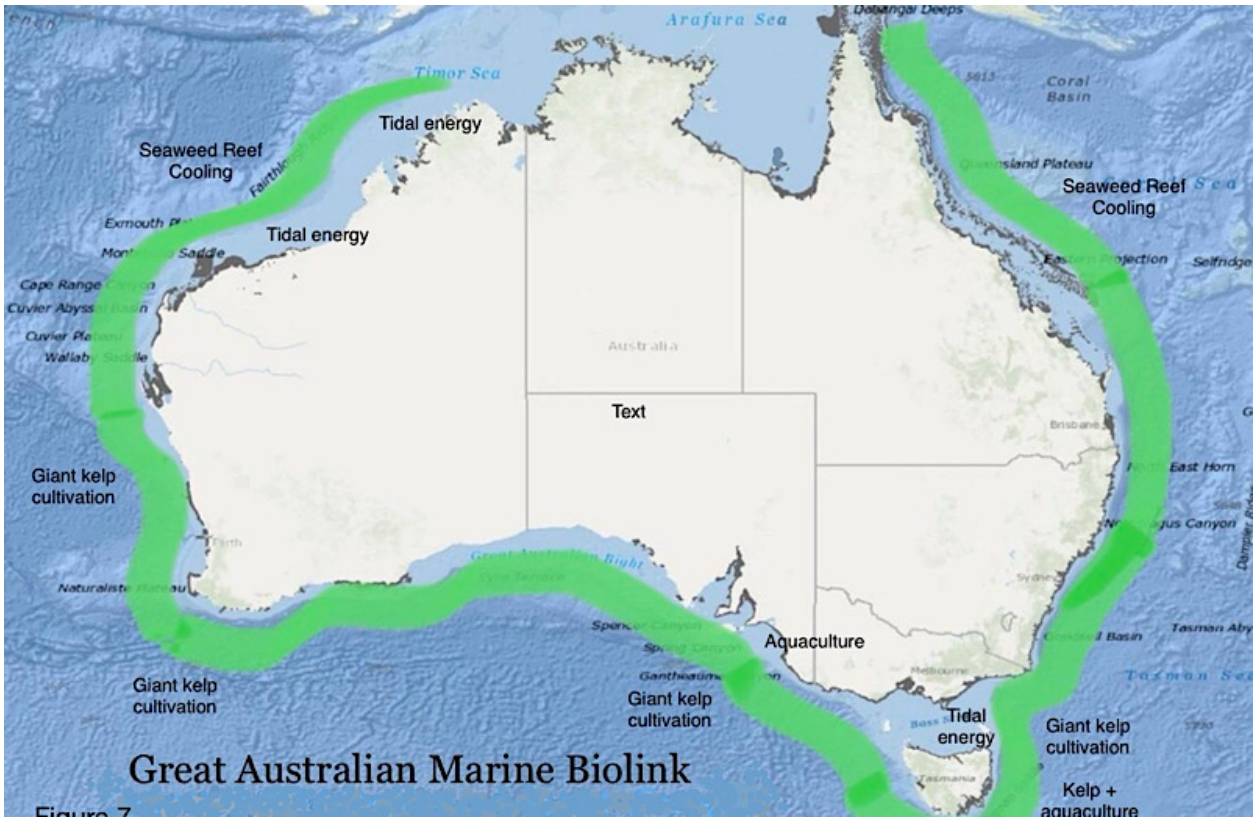


Figure 7