Surveying HMPE Synthetic Rigging (Workshop 6)

[HMPE for anchoring, mooring, towing and drogues]

Created and presented by
Nicholas (Nick) Parkyn

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AUSTRALASIAN INSTITUTE OF MARINE SURVEYORS



Taking Care of Legalities!

The information provided in this presentation is based on the best information available at the time of writing and represents guidance only. When surveying mooring systems with or without synthetic HMPE (Dyneema® / Spectra®) rope components the surveyor should enlist the services of a professional service that designs and lays moorings.

The marine surveyor carrying out the survey is fully responsible for determination of condition, fitness for purpose of any part or system and feedback and guidance given to his client. Many aspects of synthetic rope usage are complex and when in doubt the marine surveyor must enlist the assistance of an expert with experience with synthetic rigging usage in the specific application.

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Goals & Agenda

- **Goals for Part 6 – HMPE for anchoring, mooring, towing and drogues** of this webinar series will educate / upskill marine surveyors on:
  - Anchoring, mooring, towing and drogues
  - Application of HMPE (Dyneema®) for anchoring, mooring, towing and drogues

- **Agenda**
  - Presentation (50 minutes)
  - Q&A (10 minutes)



Picture courtesy M. Parkyn

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This workshop content was spawned by a question from workshop attendees

1. **Mike asked about:**
   - Use of HMPE for anchoring, mooring, towing and drogues.
   - Limitations and best practise.
2. **Darren asked:**
   - As a surveyor I am seeing an increasing number of fishing trawlers using Dyneema® for anchoring rodes. They incorporate what we used to call 'stretchers' in the towage game (short lengths of nylon line) to compensate for the low stretch in the Dyneema®. They are generally anchoring offshore in water depths 25-100 metres and have about 25 metres of chain attached to anchor before the Dyneema and the stretcher close to the securing point on the vessel. I wondered what you think of HMPE in this application as it is currency not allowed under the rule set here in Australia?

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Question 1

- Use of HMPE for anchoring, mooring, towing and drogues.
- Limitations and best practise.

We will explore these subjects and at the same time get some insights about them.

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Nylon (Polyamide) Rope

- Nylon rope stretches by 15 to 30% without affecting its strength
- Absorbs shock loads

Types Nylon Rope

3-Strand Twisted



- The most common type of rope construction and the least expensive
- Some manufacturers use the cheapest yarn to keep the price competitive
- Tends to twist or unlay when under load
- A good swivel can absorb some of these torsional loads during slack cycles.

Double Braid



- This is also a very common construction and generally a little stronger than 3-strand twisted
- It does not twist when under load but has less stretch due to its construction
- Having a core and cover the two parts can generate friction between them which can weaken the rope

Single Braid



- The least common construction
- Suggested by experts to be best construction for use with Drogues and Sea Anchors
- Does not twist under load or generate heat during load and unload cycles and has good stretch characteristics
- Typically, the most expensive rope you can buy.

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Dyneema® (HMPE) Rope

- Dyneema® rope stretches by less than 1% without affecting its strength
- 12 strand rope of 100% Dyneema® SK75 and SK78
- Dyneema® rope does not absorb shock loads



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HMPE Dyneema®

- In anchoring and mooring systems, you can always do with more shock absorption ~ snubber length.
- Snubbers must have stretch to absorb shock loading
- HMPE (Dyneema) has very low stretch and consequently has limited application in conventional mooring and anchoring systems.

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Importance of Chain in the Anchor Rode

- Rodes are either:
  - Nylon rope and chain
  - All chain
- Most anchors benefit from the weight of chain during setting in typical bottoms.
- An anchor with no chain can have a hard time resetting if it drags or pulls out.
- In deep water, the ability of the catenary to buffer loads is lost, which decreases holding ability.
- Chain is especially important when the bottom type is unknown or littered with debris.

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Mooring & Anchoring

Buoy (Swing) Mooring

- Mooring line is attached to a fixed object on the bottom
- Scope is typically lower than for anchoring
- Typically
  - All chain
  - Combination nylon rope and chain
- Shorter rode therefore less snubbing:
  - Less catenary effect as chain is short
  - Shorter nylon rope so snubbing effect from rope is less

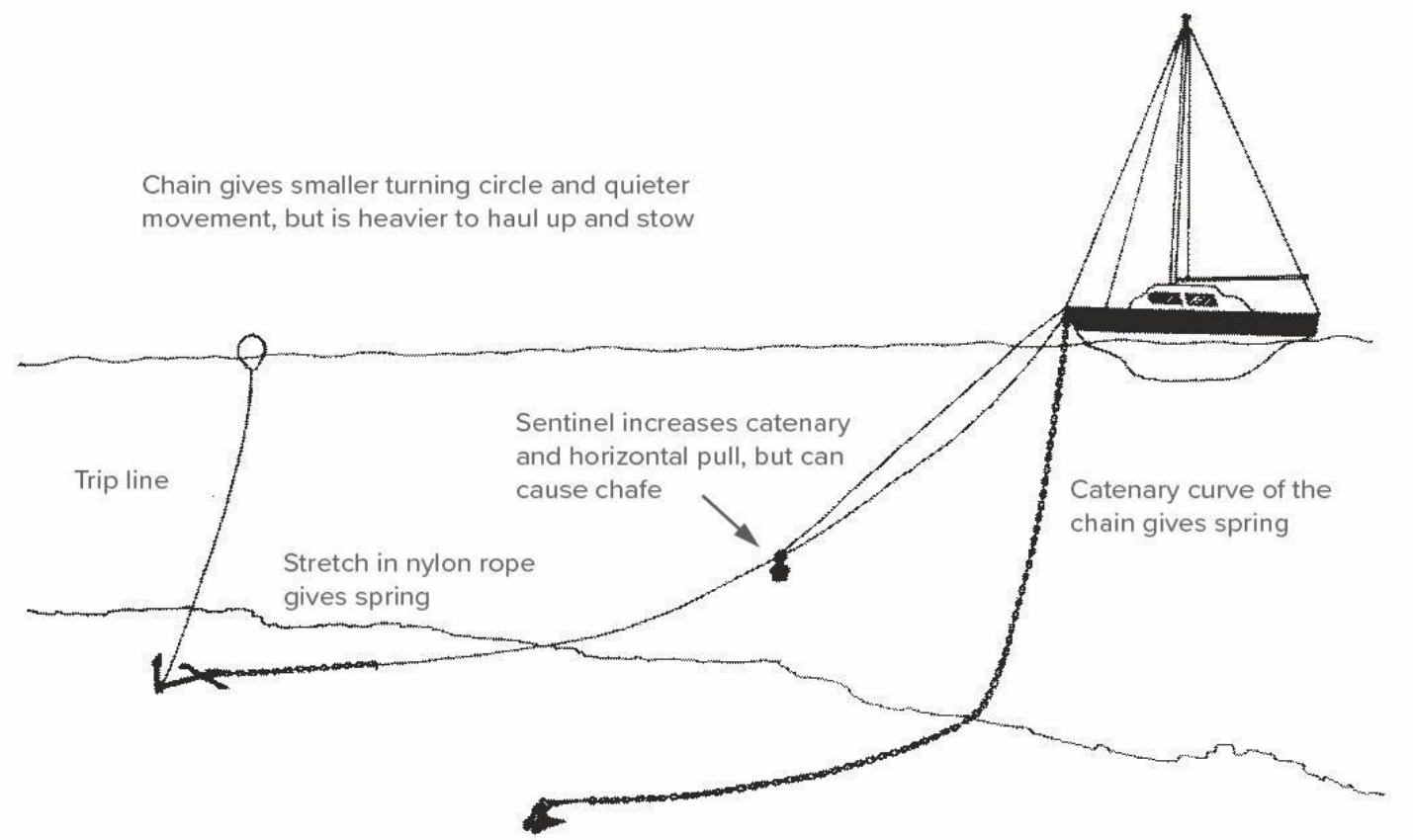
Anchoring

- Mooring line is attached to an anchor on the bottom
- Scope is large to assist anchor holding
- Typically
  - all chain
  - nylon rope and chain
- Some snubbing from:
  - catenary
  - rope stretch

MSQ indicate that swing of typical mooring is greater than planned for.

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Anchoring



Picture courtesy Jimmy Green Marine

Mooring rode is like all chain rode, but chain is shorter to reduce turning circle (swing).

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Anchor Rode Rule of Thumb

The traditional Rule of Thumb for your anchor rode:

- All-chain rode - minimum scope 3:1
- Chain/rope combination rode minimum scope of 5:1 (where the rope makes up most of the total length).

https://jimmygreen.com/content/193-anchoring-system-assessment

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Chain or Nylon/Chain Anchor Rode

- Most anchors benefit from the weight of chain during setting in typical bottoms.
- An anchor with no chain can have a hard time resetting if it drags, or the boat veers.
- In deep water, the ability of the catenary to buffer loads is lost, which decreases holding ability.
- Chain is especially important when the bottom type is unknown or littered with debris.

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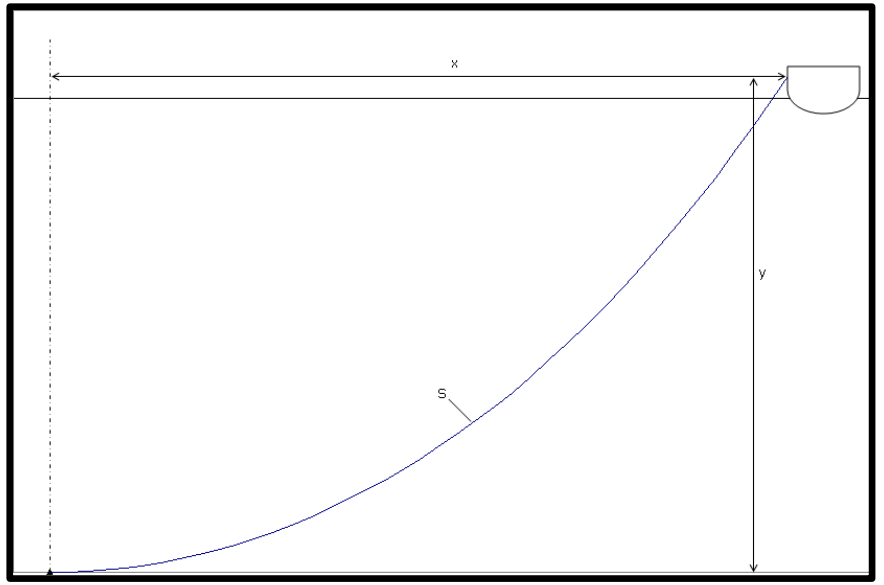
Shock Loads

- In addition to force, the steady pressure applied to a rode and anchor, conventional moorings can also experience shock loads unless they are equipped with shock absorbing components
- A properly designed conventional mooring without an additional shock absorber generally minimizes the risk of a shock load by ensuring that the dampening effect created by the weight of the bottom chain is enough to absorb the quick movement of a boat on its mooring, but under extreme conditions, this may not be sufficient.
- The elasticity of a conventional mooring must be designed to minimize shock loading.

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Chain Catenary

- In physics and geometry, a **catenary** is the curve that an idealized hanging chain or cable assumes under its own weight when supported only at its ends in a uniform gravitational field.
- The catenary curve has a U-like shape, superficially similar in appearance to a parabola, but it is not.
- The catenary produced by gravity provides an advantage to heavy anchor rodes.
- When the rode is slack, the catenary curve presents a lower angle of pull on the anchor or mooring device than would be the case if it were nearly straight. This enhances the performance of the anchor and raises the level of force it will resist before dragging.
- To maintain the catenary shape in the presence of strong wind, a heavy chain is needed, so that only larger ships in deeper water can rely on this effect.
- Smaller boats rely on catenary to:
  - Maintain maximum anchor holding power.
  - Reduce load in light to medium conditions



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The Catenary Effect

- The impact resulting from the curvature of the anchor rode is known as the catenary effect.
  - First implemented in the 1600s, the theory provides a measurement scale for anchor chain angles
- As weather conditions worsen and the boat strains, it begins to lift the anchor chain, eventually straightening it
- When that happens, the anchor can pull loose, and the boat begins to drag or drift
- Attaching a snubber to an all-chain anchor rode can act like a shock absorber and improves the catenary effect
- A typical snubber is nylon line known for its elasticity or stretch
- For an all chain rode the nylon line can be fashioned into a bridle with a chain hook in the middle that is attached to the chain
- The ends of the line are cleated off to the bow - port and starboard - while the hook grabs the anchor rode, distributing the load. Bridle systems are essential for catamarans
- For a chain and nylon rope rode, the nylon rope provides the snubbing.

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Snubbing on Anchor Rodes

- Snubbers are devices used to absorb wave energy
- A proper snubber can reduce the load by 30% to 70%
- Chain leader and nylon rope anchor rode
  - Rope section is the snubber
  - Snubber length should be 1.0 to1.3 times the LOA or at least 40 feet
- All chain rode
  - Use rope snubber
    - Offloads the winch
    - Prevents chain from grinding on the anchor roller
  - Nylon rope is used for snubber one size smaller than the required anchor rode
- Additional snubbing devices
  - Snubber addons
  - Compensators

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Snubbing for Moorings

Snubbers are devices used to absorb wave energy

- A proper snubber can reduce the load by 30% to 70%
- Chain leader and nylon rope
  - Rope section is the snubber
  - Length should be 1.0 to1.3 times the LOA or at least 12m (40ft)
  - Long rope snubbers are not practical because of swinging room limitations
  - Non-rope snubbers are useful on mooring lines because rope snubber length is limited
- All chain rode
  - Use rope snubber
    - Offloads the winch
    - Prevents chain from grinding on the anchor roller
  - Nylon rope is used for snubber one size smaller than the required anchor rode

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Snubbing for Mooring Lines

Non-rope snubbers

- Are useful on chain leader and nylon rope mooring lines because rope snubber length is limited
- These are typically, addon snubbers and compensators.

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Snubbing on Swing Moorings

- Insufficient Snubbing Capability
  - Nylon mooring buoy to deck cleat line on buoy mooring is too short
- Snubber length should be 1.0 to1.3 times the LOA or at least 12m (40 ft)
  - This is typically not achievable for swing moorings because of swinging room limitations
  - Use of addon Snubbers on the top line (line from the mooring buoy to the deck mooring cleat) is recommended particularly when Conservation Moorings are used
  - Particularly useful on some Conservation Moorings as primary snubbing is harsh

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Addon Snubbers & Compensators

Unimer Smart Snubber Features:

- Innovative design produces remarkable cushioning effect
- Simple hook-on retrofit
- No free end of the line required
- Fast and easy repositioning/adjustment
- Doubling up/multiple deployment potential
- Durable polyurethane material
- Long lasting elasticity
- Compact and easy to fit
- Suitable for mooring, anchoring, and control lines e.g. preventers

Similar products are available from several manufacturers.



Unimer Smart Snubber



Unimer In Line Mooring Compensators

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Rode Type & Loads

Rode type	Horizontal working load
Wind Load Only	670kg (1476lbs)
All Nylon Rope	814kg (1793lbs)
Long Nylon Rope Snubber with chain	850kg (1872lbs)
Short Nylon Rope Snubber with chain	2456kg (5415lbs)
Chain only	3121kg (6880lbs
Dyneema only	*Even higher than chain only*

Note:
- 60ft monohull yacht at 60knots windspeed (anchored in relatively shallow water)
- Some data used is from the book – Rigging Modern Anchors by Drew Fry.

The forces required to hold a boat in position solely against waves will generally be slight but only if ample freedom is allowed for the boat to oscillate with the waves. Allowance for this freedom is a major consideration in the proper design of a mooring or selection of anchor rode. Failure to provide this freedom may result in tremendous and even destructive surge loads.

- Anchors and Anchoring

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Rhode Type & Loads

Rode Type	Wind Speed	Wave Height	Depth of Water	Scope	Load
Cable only	22kts	0.762m (2.5ft)	7.62m (25ft)	6.8:1	2926kg (6450lbs)
70ft chain & Cable	22kts	0.762m (2.5ft)	7.62 (25ft)	6.8:1	127kg (280lbs)

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HMPE (Dyneema®) Soft shackles for Snubber Attachment

- When using an all-chain rode and nylon rope snubber, a Dyneema® soft shackles can be useful for attaching nylon rope snubbers to all chain rode
- Chafe guard in the form of sleeving should be fitted to the shackle where it touches the chain link
- The D/d ratio is poor, so the soft shackle should be replaced regularly.

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Kellet / Sentinel

- A Sentinel or Kellet is a device used to reduce the angle of the anchor rode as it extends from boat to sea bottom.
- That angle is important, especially if the amount of scope is insufficient.
- The steeper the angle, the more likely the anchor shaft will lift allowing the tines to pull free, especially if the hook has been improperly set to begin with
- A sentinel is nothing more than a separate line with a weight attached, and rigged in a way so that the heavy object known as a kellet can be shimmied at least half-way down the length of the anchor rode.
- A century ago, the kellet was typically a huge piece of lead or iron fitted with a ringbolt, which made it capable of sliding up and down along the ship’s thick anchor chain, controlled from the bow by a tagline..

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Kellet / Sentinel

- A kellet or sentinel is a device used to reduce the angle of the anchor rode as it extends from boat to sea bottom
- It is a weight placed halfway along the length of the rode to increase the chain's catenary so that the angle of pull upon the anchor moves towards the horizontal.
- The increased catenary and lowering of the effective pull angle helps the anchor dig in and stay in place.
- A kellet or sentinel works by placing a leverage point on the chain.
- For example: At an anchoring scope of 5:1, it takes a horizontal force of almost 5 times the pull to lift the sentinel off the seabed.
- Depending on conditions the deploying of a sentinel can almost double the holding power of the anchor whilst halving its workload.
- A century ago, the kellet / sentinel was typically a huge piece of lead or iron fitted with a ringbolt, which made it capable of sliding up and down along the ship's thick anchor chain, controlled from the bow by a tagline.

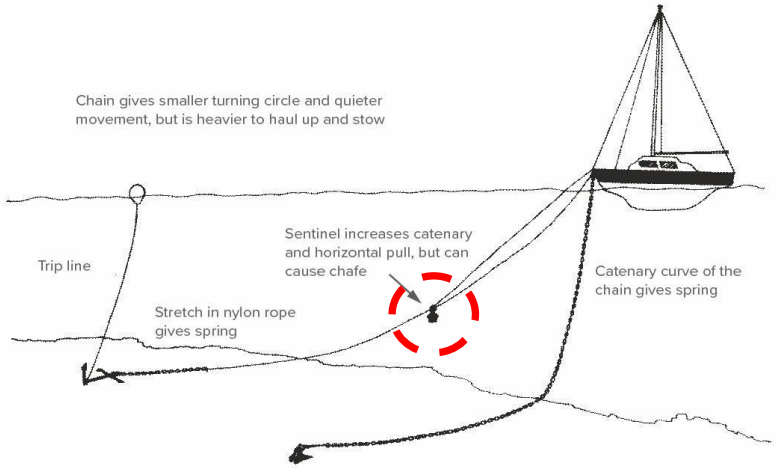


Diagram courtesy Jimmy Green Marine

A kellet or sentinel also adds shock absorption.

- A 12kg (25lbs) kellet / sentinel can bend the arc of an anchor rode so that it doesn't tug directly on the boat's bow in a straight line.
- That's one reason an all-chain anchor rode is more effective than a chain-to-rope setup—the weight of the chain creates its own dampening because it tends to sag in the middle.

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Advantages of Using a Kellet / Sentinel

- On the plus side, many sailors remain convinced a kellet can help keep a boat from sailing at anchor and prevent a rope or chain rode from wrapping around the keel or rudder.
- They also emphasize that by reducing the tension-straightened angle of a nylon anchor rode, the chance of its being severed by a passing propeller in the dark is greatly decreased.
- When time comes to retrieve the sentinel, if no crew muscle is available, a snatch block works wonders shackled on the bow.
- It is suggested that a 12kg (25lb) to 18kg (30lb) kellet deployed as a sentinel on a 18m (40ft) boat should double the efficiency of its anchor.

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Kiwi Anchor Rider

- The Kiwi Anchor Rider also dampens side to side yaw in gusty conditions and helps prevent the rode from snubbing on the windlass as it straightens out. Made in New Zealand.

Anchor Buddy CAB30



CAB30 ALL CHAIN Model
30lbs (13.6kg) nominal weight
•For all chain anchoring
•With chain up to 1/2inch (13mm) (Can also be used for rope warps)
•Suits vessels to 60 plus feet (18+m) using all chain

https://anchorbuddy.co.nz/

Anchor Buddy AB30



30lbs (13.6kg) nominal weight
•For rope anchoring
•With warps up to 5/8inch (16mm)
•Suits vessels 30 feet (9m) to 60 plus feet (18+m)

Anchor Buddy AB20



20lbs (8kg) nominal weight
•For rope anchoring
•With warps up to 5/8inch (16mm)
•Suits vessels up to 30 feet (9m)

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Conservation Mooring Systems

- Conventional moorings, as described above, rely on a heavy chain to dampen the im pacts of various forces (e.g., wind, waves, and currents) on a moored vessel.
- The heavy chain moves along the seafloor as the boat moves, disrupting the living or ganisms and destroying sea grass beds in its path creating a bare space “mooring scars”
- The degree of scarring and the extent of the scar are dependent upon factors such a s the length and weight of chain and the nature of vessel movement (e.g., currents, t idal range, prevailing wind, storm exposure).
- In addition to denuding an area of marine life, the chain sweep of a traditional moori ng and the vertical movement of the chain as water levels rise and fall can suspend s ediment in the immediate and surrounding areas. This increase in turbidity can imp air photosynthesis and disrupt an animal’s behaviour and physiological functioning.

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Seagrass Meadows

- A **seagrass meadow** or **seagrass bed** is an underwater ecosystem formed by seagrasses.
- Seagrasses are marine (saltwater) plants found in shallow coastal waters and in the brackish waters of estuaries. Seagrasses are flowering plants with stems and long green, grass-like leaves.
- Seagrasses form dense underwater meadows which are among the most productive ecosystems in the world.
- They provide habitats and food for a diversity of marine life comparable to that of coral reefs. This includes invertebrates like shrimp and crabs, cod and flatfish, marine mammals and birds.
- They provide refuges for endangered species such as seahorses, turtles, and dugongs.
- The meadows also account for 10–18% of the ocean's total carbon storage.
- Seagrasses clean the surrounding water and help take s carbon dioxide out of the atmosphere
- Seagrasses are believed to be the third most valuable ecosystem in the world (only preceded by estuaries and wetlands)
- Seagrasses are known as the "lungs of the sea" because one square meter of seagrass can generate 10 litres of oxygen every day through photosynthesis.
- A hectare of **seagrass can** annually absorb 15 times **more** carbon dioxide **than** a similar-sized portion of the Amazon **rainforest**



Picture courtesy M. Parkyn

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EcoMooring System

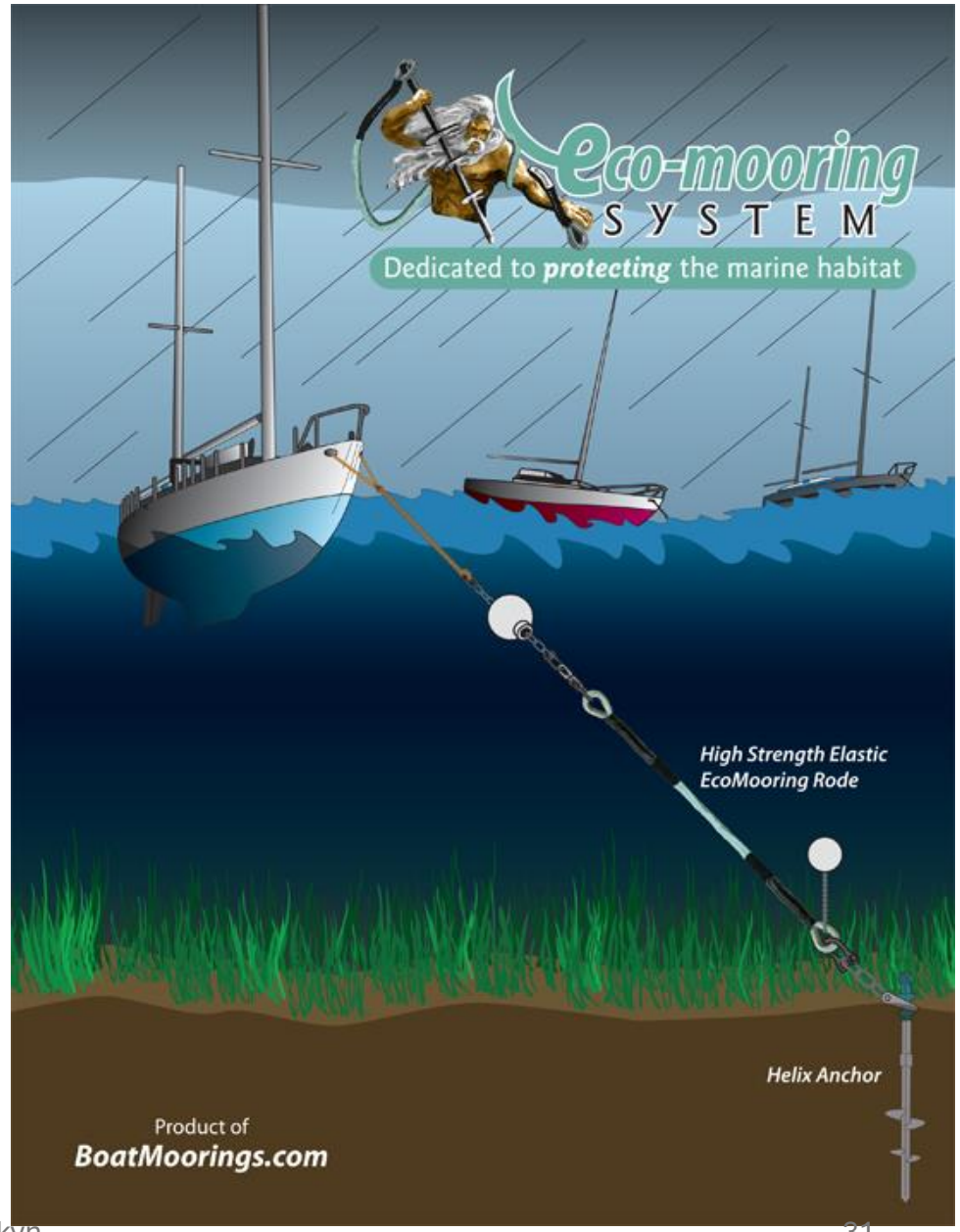
An **eco-mooring system** can be described as a mooring system that is designed to avoid contact with the seafoor, generally through the use of fexible, floatable lines.

Features

- Elasticity with strength
- Eliminates scouring of harbor bottom by chain
- Custom lengths can be fabricated
- Abrasion resistant high tensile cover
- Non-Corroding design yields longer life
- Energy absorbing polyester jacketed cover
- Can be used with variety of anchors or moorings (Best when used in conjunction with a Helix Anchor)

Advantages

- Longer life span than traditional chain
- Helps reduce chafing of pendant
- Makes it possible to shorten vessel's swing area



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Conservation Mooring Forces

- Although the force applied to the anchor is a significant factor in an anchor's holding capabilities, the angle of the force is also important to consider
- Most anchors are designed to hold best when pulled on at an angle
- During storms, swells and storm surges can cause water levels to rise rapidly. On a traditional mooring, as water levels rise, the boat is pulled back toward the anchor, and if the scope is short enough or the water levels rise enough, the boat may ultimately come to be directly over the anchor
- This would cause the boat to pull vertically on the anchor – which may compromise its holding capabilities
- While the line used on conventional moorings has some stretch capacity, conservation moorings are specifically designed to stretch (for example, the Eco-Mooring System is designed to stretch from 3.65m (12 ft) to 5.79m (19 ft), and the Hazelett system can stretch up to 200% of its length), generating more horizontal holding force earlier in the boat's movement
- In addition to the issues related to the holding capabilities of the anchor, it is also important to understand the holding capabilities of the rode system itself.

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Eco-Mooring Example

- Depth at mooring lowest tide 1.8m (5.9ft)
- Craft is 7.62m (25ft) Sports boat.

Eco-Mooring Rode Specifications

- 12 Strand Polyfiber Rope
- 12700kg (28,000lbs) Tensile Strength
- Stretches from 3.66m (12ft) to 5.19m (17ft)
- Floats above sensitive habitat
- Absorbs wind and wave motion

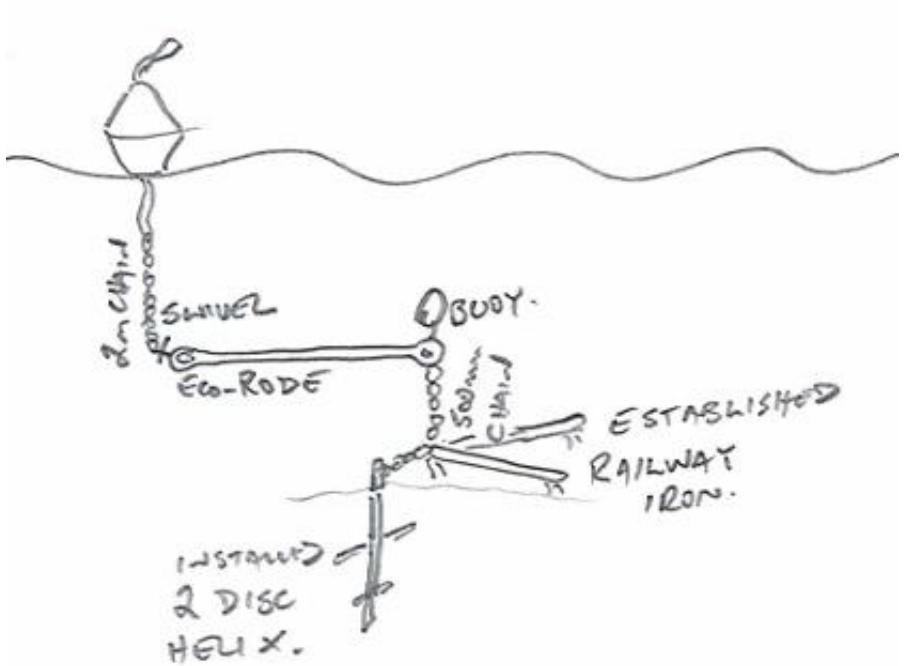




Diagram Courtesy BoatMoorings.com

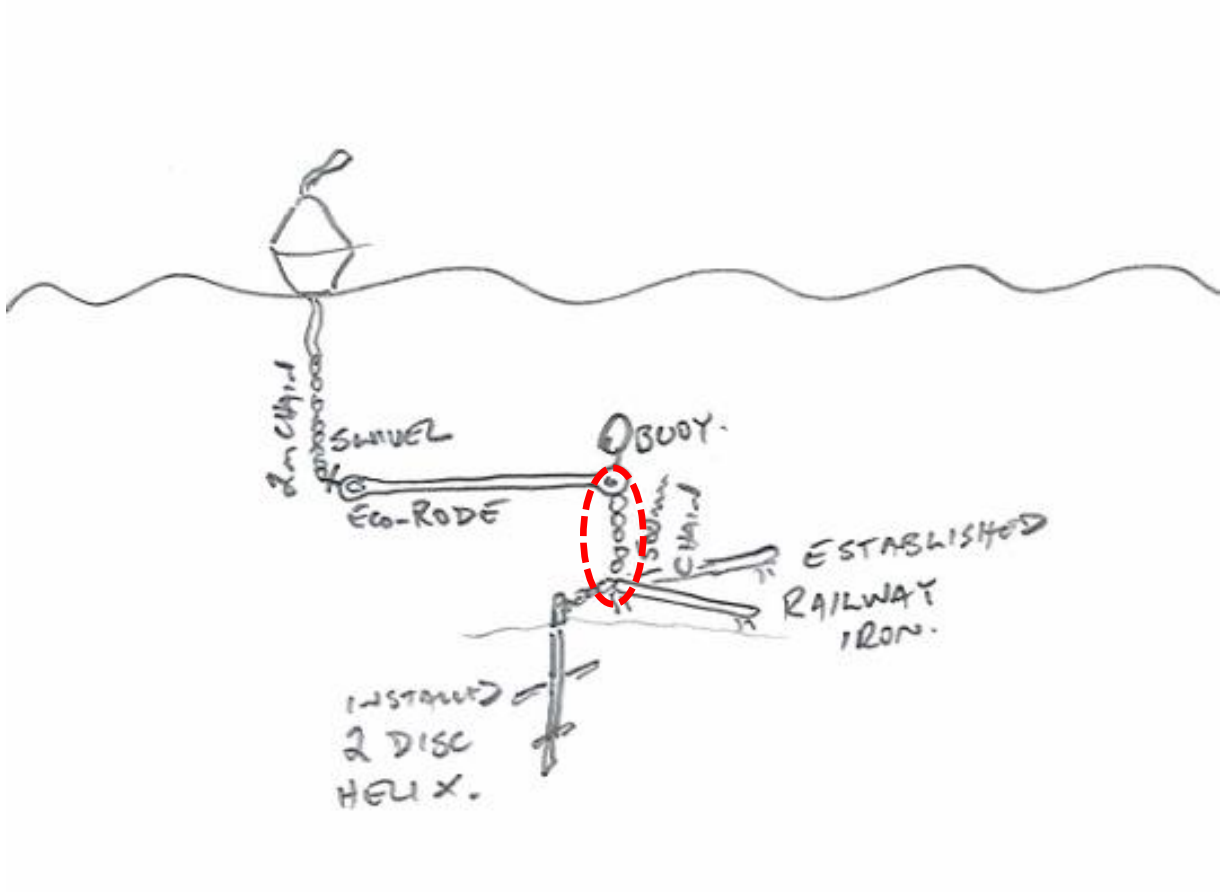


Diagram Courtesy BoatMoorings.com

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Eco-Mooring Example

- Depth at mooring lowest tide 1.8m (5.9ft)
- Craft is 7.62m (25ft) Sports boat.



In this application bottom chain could be replaced by Dyneema® line since:
Such short lengths of chain provide no dampening effect
The Eco-Mooring Rode is designed for dampening and has significant stretch.

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Conservation Mooring Systems

In Australia, two additional types of conservation moorings, exist that offer alternative approaches to elastic moorings.

- **EzyRider Mooring system**
  - This system uses a mooring buoy moves up and down a stainless-steel shaft with the waves and tides.
- **Sea Grass Friendly Mooring System**
  - This system uses a stainless-steel shock absorbing system attached to a screwed-in mooring post on the sea floor and attached to a line at the top which runs to the water surface.

System	Anchor	Buoy	Rode	Other
Seaflex System	Any anchor type, but a helical anchor or deadweight are recommended	Any, however, the company is in the process of testing a surface buoy (in Long Beach, CA) with an integrated thimble, with the intent to reduce the potential for hardware failure. The company anticipates having the buoy on the market in 2013.	Elastic rode (or rodes for greater holding strength). The system is specifically designed to become stronger as it elongates.	System often includes an "integrated by-pass" (a line made of a material called "Spectra 2000", which has a breaking strength of 50,000 lbs.). The by-pass system engages as the rode reaches 80% elongation, preventing the Seaflex system from reaching 100% elongation.
Eco-Mooring System	Various anchor types will work, but a helix is recommended	Any	Polyfiber rope that encapsulates an elastic rubber component. As the elastic component stretches, the surrounding rope (woven in a way reminiscent of a Chinese finger trap) also stretches and provides strength to prevent the rubber from breaking.	The elastic component may be attached to the surface buoy directly, or chain or line may be added to reach the necessary length.
Hazelett System	Helical anchor or deadweight (specifically a concrete or granite block)	The company has developed a spar buoy that can slip below the ice during the winter. This buoy is a standard part of the mooring system.	A polymer elastic rode (or series of rodes for greater holding strength). The rode system is held off the bottom with hard trawl floats.	A "limit line" (the orange line in figure 3) may be incorporated into the system to prevent the elastic from breaking.
StormSoft System	Various anchor types will work, but a helix is recommended	Any	A "downline" consisting of industrial rubber multi-strand cords surrounded by a braided polyester shell/rope. A continuous inner core of braided polyester maintains the position of the shock absorbing rubber.	The system has a very tight braid designed to keep marine life out of the interior of the assembly and the system has no complex metal connections.

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Drogues and Sea Anchors

Drogues and sea anchors are often naively considered to be the same

They are similar in appearance, however there is a difference in function as they perform very different roles.

Sea Anchors (anchoring devices)

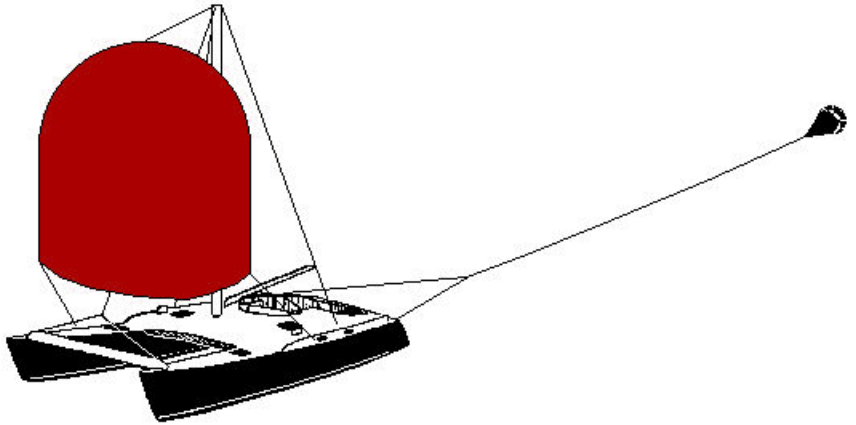
- Sea anchors are designed to stop and ‘moor’ a boat bow-to the waves.
    - They keep the yacht bow-on to the waves and prevent the yacht from broaching beam-on to the waves.
- They are used to:
    - Riding out a storm
    - Heaving-to during a storm to rest.
- A sea anchor is relatively static in the water
- Sea anchors tend to be much bigger and must be deployed on a much longer and stretchier line.

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Drogues and Sea Anchors

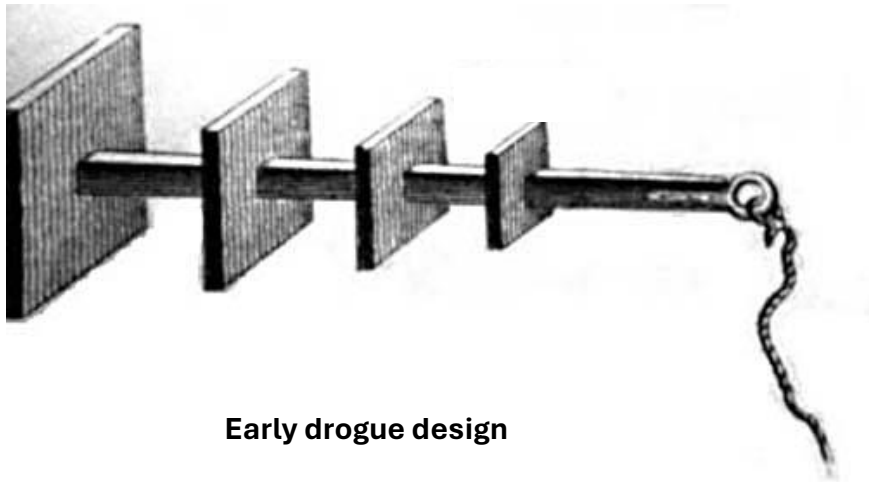
Drogues (drag devices)

- Drogues are used to keep a boat stern-to the waves
- Unlike sea anchors they are not designed to stop the boat in the
- They provide drag to slow the yacht down
- Sea anchors tend to be much bigger than drogues and must be deployed on a much longer and stretchier line
- Drogue is designed to be towed at speed



The design of a drogue is important as it must:

- Produce less drag than a sea anchor
- Be stable and resistant to spin, slew or 'porpoising'.



Early drogue design

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Types of Drogue

There are two main types of drogue

- standard single cone
- element cone-shaped drogues and their variations, and series drogues.



Single-element drogue

Are available in many shapes and sizes

- Solid plastic and metal drogues
- Fabric-types, anchors
- Purpose designed which come in a range of sizes.
  - Sea drogues often have a vent system or secondary body to keep them under control and reduces skipping and porpoising.



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Types of Drogue

Multiple drogues on the same tether

- Smaller sized drogues can be trailed one behind the other on the same warp by making them off at different points along the rode using the stainless ring.

Series drogue

- Developed by the late Don Jordan
- Series drogue comprises a long warp with upwards of 100 mini cones attached and a weight on the end.
- The warp is long enough to span two wave-lengths
- The series of cones provides not only a backup and failsafe but is also far less likely to pull out of the front of a wave, while the weight will keep the whole structure from snatching.

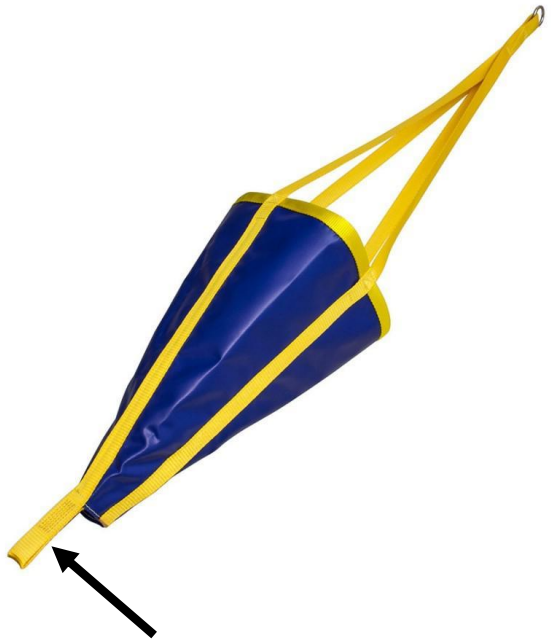




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Fabric Type Drogue Rode

- Yacht drogues are normally deployed from the stern, attached via a Nylon Octoplait rope V-shaped bridle.
- The bridle shares the shock load and can also be used to adjust the angle to the wave pattern.
- Attach the drogue to the bridle with a long nylon rope tether to reduce shock loading and to ensure that the drogue remains submerged.
- Some yacht drogues also feature a webbing loop at the narrow end of the cone for trip line attachment which aids recovery



Yacht Drogue Warp and Chain

The main principles are:

- A long nylon warp comparable with the break load of your bow anchor rode typically 100m (328ft)
- For fabric type drogues a short length of chain comparable with the break load of your bow anchor chain (typically 5m (16ft)) is required to ensure the right level of submersion of the drogue however how much weight is required is open to debate and requires experimentation.

Stretch in the rode (bridle and tether) is essential to reduce shock loads – Dyneema is NOT suitable for this application

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Usage of Drogues

Drogues can be used:

- As an emergency steering device
- To control speed and stop surfing
- To help navigate bars and narrow entrances
- To help control a boat under tow

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Drogue Example: Control speed and stop surfing

Ocean racing catamaran

Designer: John Shuttleworth

LOA: 10m (34ft)

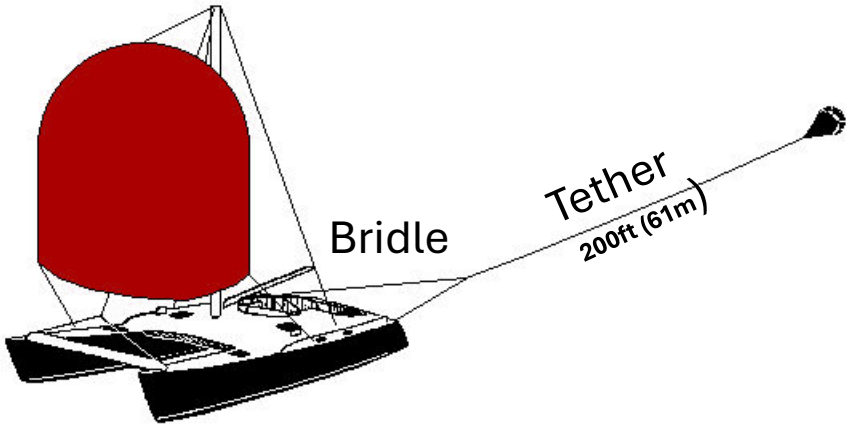
Beam: 5.5m (18ft)

Draft: 0.5m (1.5ft)

Displacement: 2 Tons

Drogue:

***Sea Squid* on *200ft (61m) x 12mm (7/16“) nylon three strand tether, with bridle arms of 30ft (9.2m)* each** and 1/2" galvanized swivel.





The dynamic loads are extremely high and good snubbing is essential.

Nylon line must be used and Dyneema rope has no application for drogues.

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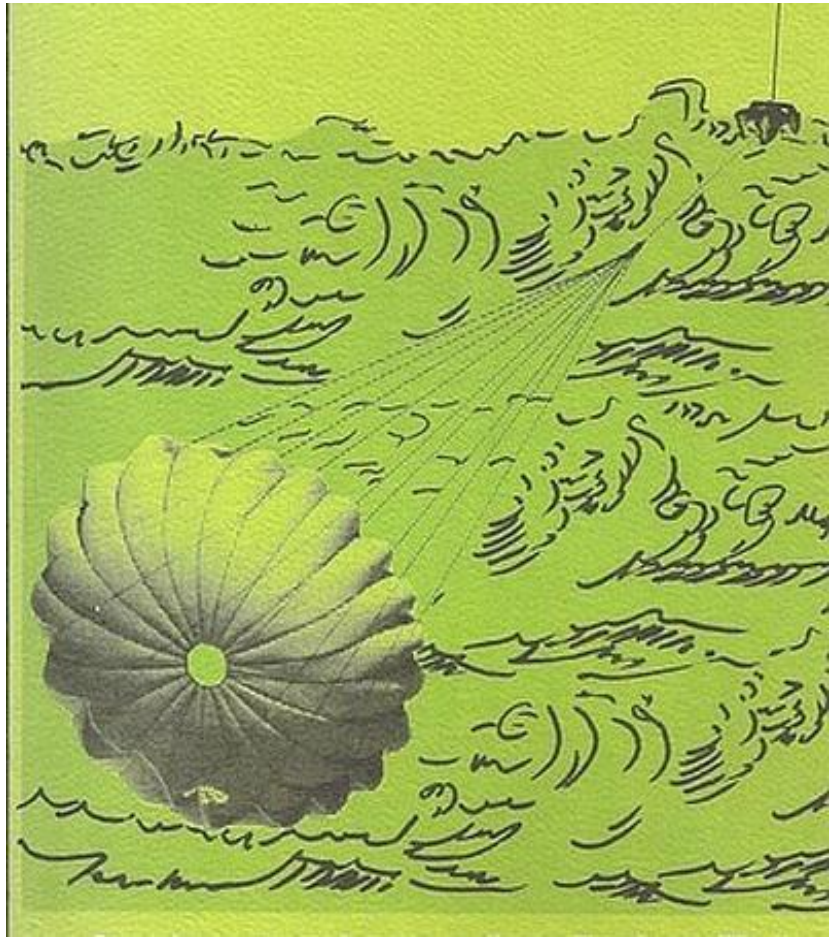
Drogues for Steering

- Using a drogue is a tried and tested way of steering
- It might be slow, but with long enough lines it will work in big seas and should get you close enough to land to be able to arrange a tow
- Rigged forward of amidships using blocks attached to the stanchion bases and two long lines (warps) so that the yacht can pivot around her keel more easily.

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Parachute Anchors

- A **sea anchor** (also known as a **parachute anchor**, **drift anchor**, **drift sock**, **para-anchor** or **boat brake**) is a device that is streamed from a boat in heavy weather. Its purpose is to stabilize the vessel and to limit progress through the water
- Attached to a vessel's bows, a sea anchor can prevent the vessel from turning broadside to the waves and being overwhelmed by them.
- Larger sea anchors are so efficient that they need a tripping line to collapse the parachute for retrieval. Being made of fabric, a sea parachute may be bagged and easily stowed when not in use.



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Types Sea Anchor / Parachute Anchor

Early sea anchors were crude devices, but today most take the form of a:

- Parachute (drogue parachute)
- Cone

Modern commercial sea anchors are:

- Typically made of cloth, shaped like a parachute or cone
- Rigged so that the wider end leads and the narrower end trails.

When deployed, this type of sea anchor floats just under the surface, and the water moving past the sea anchor keeps it filled.



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Parachute Anchor



Lalizas Sea Anchor



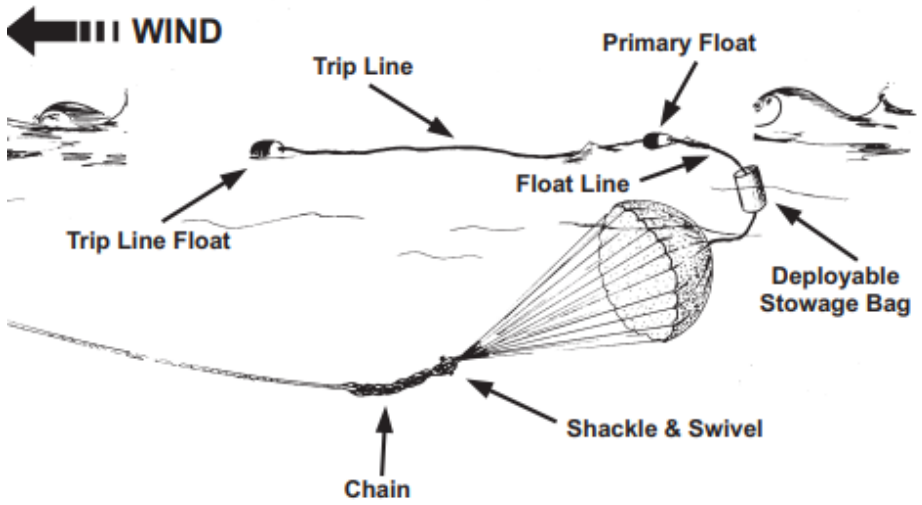
Octochute Sea Drift Anchor

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Sea Anchor / Parachute Anchor

Rodes for Sea Anchors

- The Sea Anchor relies very heavily on the stretch of the long rode for yielding to the seas (and not standing up against them).
- Use of some chain between the Sea Anchor and the boat
- Use Nylon rope as stretch is required for shock absorption - HMPE Dyneema ® rope Is not appropriate



On Multihulls:

- The overall scope of rode, including the bridle length, should be about 11 to 12 times the LOA or longer.

On Monohulls:

- In moderate weather conditions use a rode length of at least 92m (300ft)
- In heavy weather use a rode length of 10 to 15 times the overall length of the craft

Bridles for Sea Anchors

Multihulls

- All Multihulls MUST use a bridle to both hulls (abase). Each leg should be a minimum of two and a half times the beam of the boat.
- The bridle legs MUST be attached to both hulls

Monohulls

- Some advocate the use of a bridle to hold the boat in a hove-to attitude for greater stability and ride comfort.

Trip line

- Trip line should float and can be Polypropylene or HMPE(Dyneema®) could be used but would not be cost effective.

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Dyneema on Secondary Anchor

- Testing by Practical Sailor (see Anchor Rode Report, Practical Sailor, February 2014) and others confirm that a thin rode can increase both the setting depth and holding capacity.
- The more deeply an anchor sets, the more secure it is in wind shifts, and an anchor that sets more deeply can be slightly smaller.
- This is helpful, since most sailboats don't have enough power in reverse to set a large anchor well.
- A boatowner swapped the 30-foot chain leader on his secondary anchor for 20 feet of Dyneema single braid
- The Dyneema leader, splices, shackle connections and all, were covered with chafe sleeving, which has allowed better handling, demonstrated excellent resistance to chafe when used as free-floating line.

This is an unconventional arrangement suitable for special circumstances of a shallow, soft bottom and is NOT a primary anchor.

It is not meant to replace a primary anchor with all chain or nylon/chain rode.

- Most anchors benefit from the weight of chain during setting in typical bottoms.
- An anchor with no chain can have a hard time resetting if it drags, or the boat veers.
- In deep water, the ability of the catenary to buffer loads is lost, which decreases holding ability.
- Chain is especially important when the bottom type is unknown or littered with debris.

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New Ropes

LIROS - Handy Elastic

- LIROS refer to Handy Elastic as their ultimate shock absorbing mooring line.
- LIROS Handy Elastic is manufactured from 100% Polyamide (Nylon) resulting in a maximum load capacity, maximum shock absorbing mooring line.
- High-stretch, extremely abrasion resistant mooring line, towline or anchor line.
- Specially designed with high elastic fibres.
- Can be used for shock absorption in extreme environments
- Working stretch > 20%
- Very easy to splice
- Highly elastic and highly UV-stable
- Extremely abrasion resistant.

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New Ropes

Mooring floating rope from Amare Ropes

The latest new rope concept for floatable moorings and towing lines. The balanced twisting of Dyneema® SK78 with Polypropylene guarantees a good breaking load and elongation, to improve the comfort on board.

NOVUS LINE DYN+PP

- 8-strand braid in Dyneema® SK78 + Polypropylene H.T.



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Maintenance of Moorings

- Moorings of any type should be maintained at least annually
- During annual and official inspections, gear (e.g., shackles, chain, thimbles, lines, rodes, etc.) may need to be replaced.
- Maintenance will vary depending on factors such as exposure to current and waves, biofouling organisms, highly corrosive environ ments, electrolysis, and high frequency/intensity of storm events.
- Maintenance will also vary depending on the type and quality of mooring equipment being used.
- Helical anchors are drilled into the seabed where they are not likely to corrode, and many helical anchors removed 10 years after i nstallation show no signs of corrosion.
- When comparing conventional and conservation moorings, therefore, the primary difference in terms of maintenance needs is th e frequency of having to change or repair the rode.
- Chains, or segments of chain, require replacing approximately every two to four years (this will vary depending on environmental factors).
- Eco /
  Conservation mooring rodes such as the Seaflex, Eco-Mooring System, StormSoft moorings, and Hazelett moorings, on the other h and, require fewer replacements over the life of the mooring.
  - All four companies noted that their systems could be in place for more than 7 years without losing their design capacity, but the technology is still relatively new and exact life expectancies under various conditions have not yet been
- The mooring should be inspected annually, and the chain should last 3 to 5 years.
- The Eco Rode should last 5 years rodes overseas have generally lasted in excess of 5 years.
- The Helix Anchor will last well over 10 years.

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Surveying Moorings

- To survey a permanent mooring thoroughly it must be brought ashore
- Often moorings are inspected by divers to avoid the disruption and cost of beaching all the tackle – this is a check not a survey!
- A surveyor looks for wear and corrosion and must check every part of every chain, rope and linkage
- As the chain has been immersed in water typically salt water it rusts a lot and needs hammering to remove the rust before the remaining metal thickness can be measured – a welder's chipping hammer is well suited to this task.



Welder's chipping hammer

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Offshore Deepwater Mooring Systems

- Offshore can expose the mooring system to greater wave and current movements
- Just as the elasticity of polyester is a limiting factor at ultra-deepwater depths, so too can be the stiffness of HMPE (Dyneema®)
- In high storm and hurricane risk areas, the mooring system needs some extension to ensure storm survivability

A solution that is used is hybrid moorings.

- Hybrid mooring lines combine HMPE (Dyneema®) rope segments with polyester rope segments, to give a mooring that is neither too stiff nor too soft.
- They allow the mooring system designer to ‘engineer’ the mooring line’s stiffness and use the lengths of Polyester and HMPE (Dyneema®) segments to provide the stiffness needed to handle maximum loads during station-keeping in a storm, while ensuring sufficient elasticity to damp peak loads induced by waves.
- Dyneema SK78 HMPE fibre has been approved by ABS and Bureau Veritas for use in offshore mooring systems anywhere in the world.

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Offshore Deepwater Mooring Systems

The preferred hybrid rope configuration is the stiffer HMPE (Dyneema®) rope in the cooler water close to the seabed, and polyester rope in the warmer waters closer to the vessel.

In high storm risk areas, the percentage of HMPE (Dyneema®) to polyester line lengths used in the hybrid mooring configurations will change as water depth increases,

For example:

- 1829m (6000ft) water depth: 50% / 50% HMPE (Dyneema®) / Polyester
- 2286m (7500ft) water depth: 60% / 40% HMPE (Dyneema®) / Polyester
- 3048m (10000ft) water depth: 75% / 25% per cent HMPE (Dyneema®) / Polyester.

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Towing – Hybrid Rope

For towing applications:

- Hybrid rope approach should be applicable and could be used to replace steel cable / nylon line
- Use HMPE (Dyneema®) SK75 or SK78 in place of steel cable and nylon rope “stretchers” for snubbing
- Ensure good D/d (greater than 5.0) and correct throat angle on the terminators to control fatigue
- Apply chafe protection

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Latest Tow Ropes – All HMPE (Dyneema®)

COMBINATION TOWING ROPES

- The newest patent pending generation of wide tow ropes from Hampidjan combines the best and most advanced materials available today from Dyneema®.

- The onboard sheave section and the outer end is made of DynIce Ultrabend based on Dyneema® XBO. The main length in-between is then made of DynIce 75 (SK75) or DynIce 78 (SK78).

DYNICE® 78 ROPE – ULTRABEND

- The DynIce Ultrabend 78 is based on the new bending fatigue resistant fibre Dyneema® XBO with same low creep properties as SK78.

- The bending fatigue tolerance is up to 5 times higher than for DynIce 78 and therefore very suitable for running rigging which must tolerate a lot of bending under high load and high temperature.

Chafe Prevention

- Use terminators that protect against chafe
- Use HMPE Dyneema® sleeving to prevent chafe at bow roller and at spliced eye attachments



Unlike conventional thimbles, Samson's Nylite Assemblies are easily installed into or removed from a premade soft eye. Weighing less than metal thimbles, Nylite will not deform or rupture from repeated loadings. The Nylite Shackle was designed to take full advantage of the high strength of the Nylite connector and synthetic rope.



The Blue Line Thimble is compatible with Samson's high-performance, high-modulus synthetic fibre rope products such as AmSteel®-Blue, Force-8, and DPX®-75.
The tubular gusseted design creates a high-strength thimble that protects the rope and maintains the proper bending radius (D/d ratio) when connected to mating hardware





Donaghy's Chafeguard is a protective wear sleeve made from Stealth (UHMwPE) fibre. Dyneema® chafe sleeving is available from most rope manufacturers.

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Question 2

- As a surveyor I am seeing an increasing number of fishing trawlers using Dyneema for anchoring rodes.
- They incorporate what we used to call 'stretchers' in the towage game (short lengths of nylon line) to compensate for the low stretch in the Dyneema.
- They are generally anchoring offshore in water depths 25-100 metres and have about 25 metres of chain attached to anchor before the Dyneema and the stretcher close to the securing point on the vessel.
- I wondered what you think of HMPE in this application as it is currency not allowed under the rule set here in Australia?

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Response to Question 2

I do not have any specific experience with this application and consequently cannot have an opinion on suitability or in any way suggest fitness for purpose.

However, I can suggest areas that you should pay attention to:

1. D/d ratio of the terminators on the Dyneema components and would suggest that terminators that can provide the correct D/d be used. You could look at https://www.samsonrope.com/hardware/blue-line-thimble/

2. Dyneema eyes must have Locked Brummel splices with very long bury possibly 100 times the rope diameter and tails must be tapered.

3. The splices must be sewn and whipped above the eye and on the tail

4. Chain catenary reduces the pull angle and reduces some of the shock loads, so using some chain and some Dyneema would probably increase the shock loads.

5. The length of the snubber has a great effect on the shock load, so you would not want Dyneema line length to reduce snubber line length.

6. Some data from the book – Rigging Modern Anchors by Drew Fry indicates for 60ft monohull yacht at 60knots windspeed (anchored in relatively shallow water)

7. The book – Rigging Modern Anchors by Drew Fry indicates is very informative on actual loads / examples and formulae for snubber lengths.

I think that you might consider it as follows:

- It is not that the Dyneema if sized and terminated correctly would not work,
- it is that the Dyneema is “effectively stiffer” than the chain (Item 4 above) that it replaces and consequently would increase the shock loads of the mooring system.

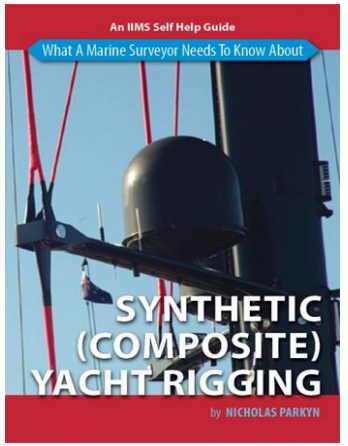
Item 2 above may be why it is not approved.

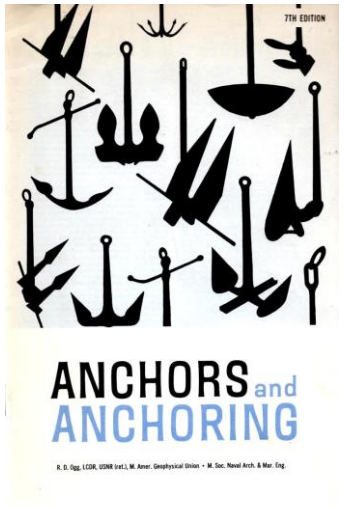
I must emphasize that I do not have any direct experience with this application and consequently cannot have an opinion on suitability or in any way suggest fitness for purpose.

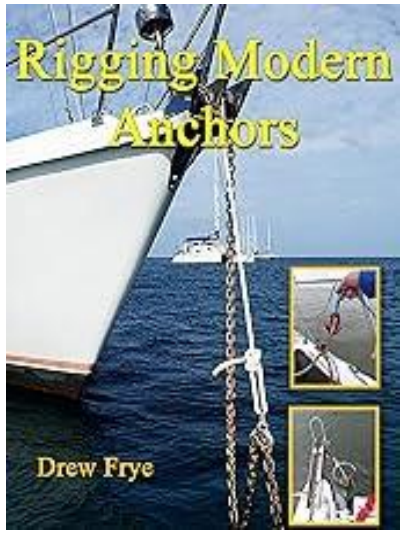
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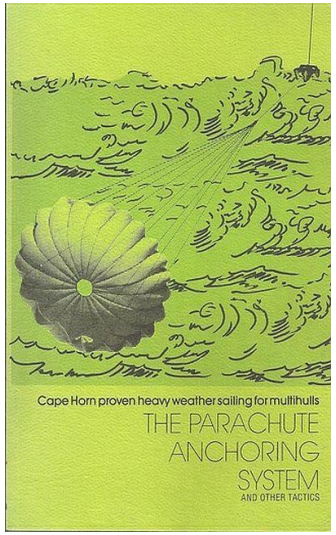
Resources

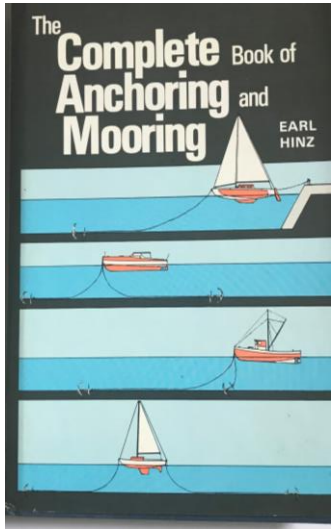
- Book - “What a marine surveyor needs to know about synthetic (composite) yacht rigging” https://www.iims.org.uk/product/what-a-marine-surveyor-needs-to-know-about-synthetic-yacht-rigging/
- ABS GUIDANCE NOTES ON THE APPLICATION OF FIBER ROPE FOR OFFSHORE MOORING AUGUST 2011 (Updated February 2014 – see next page) -https://ww2.eagle.org/content/dam/eagle/rules-and-guides/archives/offshore/90_fiberrope/fiber_rope_gn_e-feb14.pdf
- Jordan Series Drogues - https://jordanseriesdrogue.com/D_14.htm
- Victor Shane's Drag Device Data Base - https://dragdevicedb.com/
- Book – Rigging Modern Anchors by Drew Fry
- Anchors and Anchoring by Robert Danforth Ogg ASIN : B00173185U
- US Coastguard Report (May 1987) - Investigation in the use of drogues to improve the safety of sailing yachts https://jordanseriesdrogue.com/pdf/droguecoastguardreport.pdf
- Eco-Mooring BoatMoorings.com - https://www.boatmoorings.com/eco-mooring.php
- Kellet / Sentinel - https://eoceanic.com/sailing/tips/26/108/bolstering_ground_tackle/
- Jimmy Green Marine - https://jimmygreen.com/content/4-about-us
- Kiwi Anchor Rider - https://anchorbuddy.co.nz/
- Donaghy’s - https://www.donaghys.com.au/about-us
- Samson Rope - https://www.samsonrope.com/about
- Hampidjan - https://hampidjan.com.au/











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Questions & Answers

"Most people spend more time and energy going around problems than in trying to solve them."

–Henry Ford.

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