

FIORENTINO Technical Report FPA-124

Report Prepared for:
Fiorentino Para Anchor
Quickline USA



RESULTS FROM FLAT ROPE USED IN DROGUE DRAG TESTS CONDUCTED OUTSIDE LONG BEACH HARBOR, CALIFORNIA, April 4, 2008

Zack Smith

This report presents data on drag characteristics of four manufactured drogues deployed from Quickline's flat rope and reel. Test results measure the amount of force placed on Quickline's flat rope, as well as vessel speed with and without a deployed drogue and with and without chain weight connected to a drogue. Previous drag test results from other tow tests using 5/8-inch (16mm) deployment rode are also included for comparison purpose. The same four drogues used in the flat rope tests were also deployed in the braided rode drag tests.

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DEFINITIONS

FLAT ROPE – For the purpose of this report, a one-inch wide Dacron webbing with a listed break strength of 5,500 lbs. (2,495 kg).

DEPLOYMENT RODE – For the purpose of this report, a double braid 5/8-inch (16mm) anchor rode made from nylon fiber. Listed break strength is 16,000 lbs. (7,258 kg).

REEL – A device designed to roll up the flat line. For the purpose of this report, a stainless steel reel is used to wind up one-inch flat rope (webbing).

TENSION LOAD CELL – A device that measures the amount of force placed on the object to which it is attached. For the purpose of this report, a remote tension link, ending with an eye-and-eye attachment, was used for the drag tests. The load cell was set at 20,000 lbs. (9,072 kg) x 2 lbs. (1 kg) graduations.

TENSION LOAD INDICATOR – A battery-operated digital indicator required to register load numbers on a small monitor.

STORM DROGUE – An underwater device deployed from the stern of a marine vessel to slow, (not stop) its forward motion to improve steerage in large seas.

UNITARY/ SPEED-LIMITING DROGUE – A single, canopy drogue made from an open or solid fabric. Designed to slow, not stop a boat.

SERIES/ STOPPING DROGUE – A long length of anchor rode with multiple fabric cones woven into the rope. A stopping drogue is designed to point the stern into approaching waves by nearly stopping the boat's drift rate.

STORM DROGUE CANOPY -- Fabric sewn to dome-or-cup like shapes that capture water.

STORM DROGUE SHROUD LINES -- Sewn lines or webbing that fall away from the canopy and join at a hardware attachment point.

PARA-RING – Unconventional hardware used in place of shroud lines on the Shark drogue.

DROGUE TAIL – A rode that passes through the center of the Shark drogue and out the backside for the sole purpose of attaching a secondary drag device, including (but not limited to) chain, ground anchor, or storm drogue.



A Tension Load Cell measures force placed on boat cleats, drogues, and flat rope.



Load Cell Indicator records the lbs. of force placed on boat and drag device equipment. Data can then be analyzed for drogue comparison.



Quickline's reel is used to coil and store flat rope.

INTRODUCTION

This report summarizes the conclusions of recent tests using one-inch (25 mm) flat rope – as a potential alternative to standard 5/8-inch (16 mm) anchor rode – for storm drogue deployment. Deployment observations with flat rope include: Ease of use, resistance to tangles, and ease of retrieval.

This report also uses details on storm drogues, manufactured from four popular companies, to measure drag characteristics. Drag characteristics include: Vessel speed reduction, amount of force placed on equipment, and drogue behavior.

For the purposes of this report, drag characteristics are calculated using a “knot meter,” to observe how much a power catamaran slows down with different drogues deployed from the stern. Additional tension load cell readouts were measured to determine amount of force placed on boating equipment. (Force calculations provide a glimpse into fabric effects on drag characteristics.)

Excerpts from past drag tests incorporating 5/8-inch (16 mm) braided rode, instead of flat rope, are placed at the end of this report for comparison purpose pages 30-41. Rode length recommendations by manufacturers are located on page 42. Information on a specific drogue is derived from manufacturers’ websites and printed manuals to establish objectivity. Only the most up-to-date information from these companies is used. However, manufacturers can change their data as they review this report and previous assessment about their products.

All observations published in this report remain the professional opinion of Zack D. Smith and Fiorentino’s research team who witnessed the analysis process. Drag tests were developed and managed by Smith. Test results and procedures were verified by Dr. Jim Warner. Dr. Warner is a Mechanical engineer with 32 years experience with the Department of the Navy, who worked both at the Naval Undersea Research and Development center and the Naval Oceans Systems Center.

Every effort has been made to make these layouts, charts and data as simple, complete, and accurate as possible so that any organization can repeat the experiments on additional vessels to confirm the integrity of said tests. The tests were also documented on video.

Throughout all tests, the same standardized equipment was used: 1) Tension Load Cell; 2) Tension Load Indicator; and 3) Catamaran Power Boat.

Gerrard Fiorentino, in conjunction with Fiorentino Para Anchor, and Randy Boelsems, in conjunction with Quickline USA, sponsored these tests. Fiorentino Para Anchor and Quickline USA processes and evaluates chart data to provide drag characteristics and other vital statistics, as they deem necessary. By no means does this report on its own merit, provide complete information necessary for the use of flat rope, braided rode or storm drogues.

ON-THE-WATER DRAG TEST

04-04-08

Four different drogues were towed behind a 42-foot (13 m) power catamaran to complete eight drag tests outside Long Beach Harbor.

In the first test, a single drogue was attached to a 30-foot (9 m) length of one-inch flat rope. The second series of tests included the use of 100-feet (30 m) of flat rope for each of the four drogues deployed. The third series of tests included the use of a 40-foot (12 m) pendant line that was connected to the 100-foot (30 m) flat rope to form a V-shaped bridle.

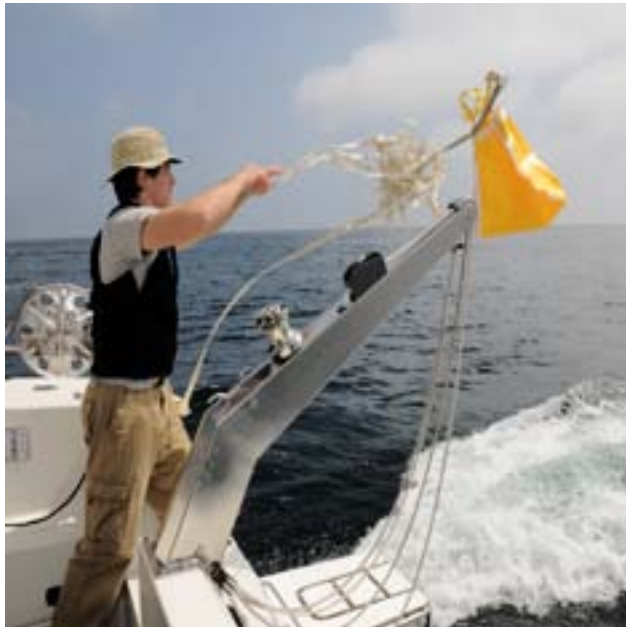
The one-inch (25 mm) flat rope was secured to a load cell capable of measuring drogue strain up to 20,000 lbs. (9,072 kg). The load cell was attached to a cleat located on the starboard stern near the transom. Drogues were deployed after the powerboat reached a speed of 7.0 knots. Together, the port and starboard engines produced approximately 2000 RPMS for each trial.



SPEC. SHEET—CATAMARAN POWER BOAT

Length (loa):	45' (13.7 m)	Weight:	16 tons
Length (wl):	40' (12.2 m)	Draft:	3'5-ins. (1.2 m)
Beam:	21'5-ins. (6.4 m)	Cruising speed:	18 Knots Both Engines
Load Cap:	20 gross tons	Maximum Speed:	25 Knots Both Engines
Fuel Cap:	290 gal	Engine HP (each):	Twin Cummins 300 Hp
Water Cap:	120 gal		

THE FOUR DROGUES DEPLOYED WITH FLAT ROPE



A 48-inch Delta Drogue is designed for a vessel up to 35-feet (11 m) LOA.



A 30 x 36-inch Galerider Drogue is designed for vessels up to 10,000 lbs. (5 tons) displacement.



A Series Drogue with 103 cones is designed for vessels up to 15000 lbs. (7.5 tons) displacement.



The Small Shark Drogue is designed for vessels from 32 to 49-feet (10 to 15 m).

PROJECT OBSERVATIONS

Weather Conditions

During the course of the test, the ocean was calm with an average of 5.3 mph (5 knots) wind (sea state 1). All drag tests were conducted with the wind blowing across the beam.

Deployment Procedure

Drogues were all deployed from the stern of the power catamaran. Attached to each drogue was a one-inch flat rope that was secured to a single eye located on the tension load cell. On the opposite side of the load cell was another eye that was shackled to a starboard cleat. Slack flat rope was gathered up in one hand, and the opposite hand held a speed-limiting drogue. Then, both were tossed overboard.

The only exception was the series drogue (stopping drogue) because of its bulkiness and heavy weight. In this case, the flat rope was flaked on top of the drogue – which was stored inside a large plastic container – then the unit was dumped into the water.

The power catamaran moved forward at approximately 7.0 knots of speed with each drogue deployment.

Tension Load Cell

The tension load cell resting on the starboard stern quarter registered 42 to 50 lbs. (19 to 23 kg) on the load cell indicator (prior to drogue deployment). These numbers were deducted from totals before the final figures were placed into the “Load Cell Readout with Drogue Deployed,” section in the “Drag Characteristics Charts,” pages 15-17.

Force measurements are also affected when drogues rise and sink in the ocean. Drogues that “surface” grab less water (therefore slowing the boat less) to reduce the amount of force placed on equipment. The opposite occurs as a drogue sinks, because it grabs more water to slow the boat, thus increasing force on equipment.

One-Inch (25 mm) Flat Rope Compared to 5/8-inch (16 mm) Deployment Rode

Because it is so lightweight, much of the flat rope used in the drag test sat above the water as various drogues were towed behind the catamaran. Flat rope is much lighter in weight than 5/8-inch (16 mm) deployment rode. One-inch (25 mm) flat rope weighs approximately 2.5 lbs. (1.1 kg) for every 100-feet (30 m) compared to 5/8-inch (16 mm) rode with a weight of 9.5 lbs. (8.9 kg) for every 100-feet (30 m).

Another factor to consider is the power catamaran's high freeboard of five-feet (1.5 m). High free board does present an angle that increases vertical pull on rope. Adding weight like chain or a ground anchor to the flat rope or drogue has the potential to place enough force on the rope so that it sits more horizontal.

Past drag tests originated by Fiorentino, seem to indicate the importance of using approximately 20-25 lbs. (9 to 11 kg) of weight with 5/8-inch (16 mm) rode for drogue deployment in heavy weather. Such analysis supports prudence in considering approximately 20-25 lbs. (9 to 11 kg) of weight for a flat rope system much sooner.

Flat Rope Length

100-feet (30 m) of flat rope was deployed because the ocean was calm with a sea state of 1. The shorter length of line also made it easier to observe drogue behavior. Typically, extreme weather conditions require an average of 300 to 600-feet (91 to 182 m) of rode for drogue use. This rode length formula developed by Fiorentino in 1947, equals out to 10-feet (3 m) of rode to every foot (0.31 m) of boat (LOA—Length Overall, excluding bow sprits). (See page 42 -- for drogue manufacturers' rode recommendations).

Fiorentino Bridle Set-Up

A 40-foot (12 m), 5/8-inch (16 mm) anchor rode – with a snatch block at the end of it – was attached to the one-inch (25 mm) flat rope, forming a V-shaped bridle. The bare end of the 5/8-inch (16 mm) rode was secured to a cleat, located on the vessel's port quarter. Fiorentino's bridle set-up had little effect on reducing the amount of force placed on the one-inch flat rope.

Computerized readouts on the load-cell indicator registered a reduction in force anywhere from zero to 104 lbs. (47 kg). In one circumstance, there was a slight increase in the amount of force placed on the flat rope. The increase occurred as the drogue sank deeper underwater creating more drag to slow the boat. In fact, the "Drag Speed Characteristics" Chart supports this theory, because the catamaran slowed an additional 0.3 knots as the drogue submerged.

Drogue Effect on the Helm

In the course of testing, drogues deployed from a single line on the starboard quarter tended to yank the vessel in the direction of the attached drogue. Our helmsman compensated by steering more to port. (Typically, this type of catamaran behavior doesn't occur until the weather becomes "sloppy," with seas reaching 12-feet and above.) Overall, the bridle set-up did improve steerage.

Drogue Retrieval

All the drogues were pulled in by hand, as the weather was calm. We only opted for engine power during the retrieval of the Jordon Series drogue (stopping drogue).

DROGUE OBSERVATIONS



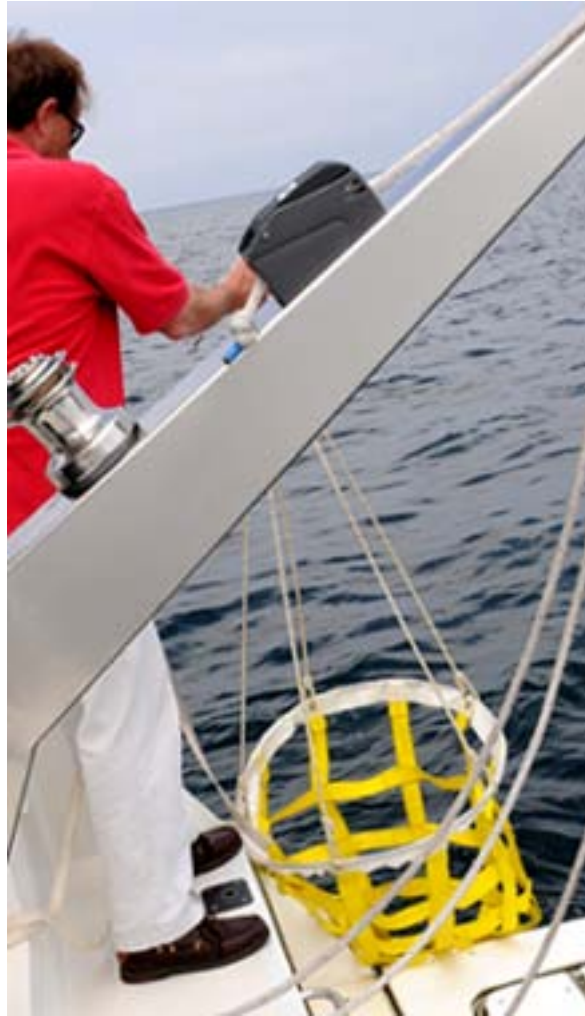
Delta Drogue

The lightweight Delta drogue was easy to deploy with the flat rope. But, as we towed the drogue behind the catamaran, the one-inch (25 mm) flat rope and webbed shroud lines on the drogue wound-up and twisted. Such a tangle could present a number of problems if the drogue is deployed in heavy weather.

This is a typical problem with a swivel that doesn't spin properly on the drogue. Continuous tension placed on the rode, connected to the drogue, is why there tends to be a high failure rate with swivels, especially the small swivel used on the Delta drogue. The swivel malfunction and tangled shroud lines did not affect the performance of the flat rope or drogue in calm conditions.

Retrieval was easy since the ocean was calm.

Weight Placement: To keep this drogue submerged, chain must be connected at the tail end of the flat rope. Chain can be cumbersome to deploy, and difficult to retrieve, because of its length. The manufacturer recommends 10 to 20-feet (3 to 6 m) of 3/8-inch (10 mm) chain attached to the drogue's swivel.



Galerider Drogue

The lightweight Galerider drogue was easy to deploy with the flat rope. As we towed the drogue behind the catamaran, the one-inch (25 mm) flat rope and braided shroud lines on the drogue did not wind-up or twist.

Open fabric drogues typically spin less because they hold very little water. However, approximately a third of the drogue sat out of the water through most of our drag test. This phenomenon can hinder the drogue's ability to slow the boat down.

Retrieval was easy since the ocean was calm.

Weight Placement: To keep this drogue submerged, chain must be connected at the tail end of the flat rope. Chain can be cumbersome to deploy, and is difficult to retrieve, because of its length. Manufacturer does not specify chain or any weight for their drogue.



Series Drogue



Series Drogue

The Series drogue was heavy to deploy as a result of the 5/8-inch and 1/2-inch (16 and 12 mm) anchor rode into which the 103 cones are spliced. So we chose to deploy the series drogue from a plastic tub, all at once. (The manufacturer-recommended method is to slowly pay the cone-ridden line out.)

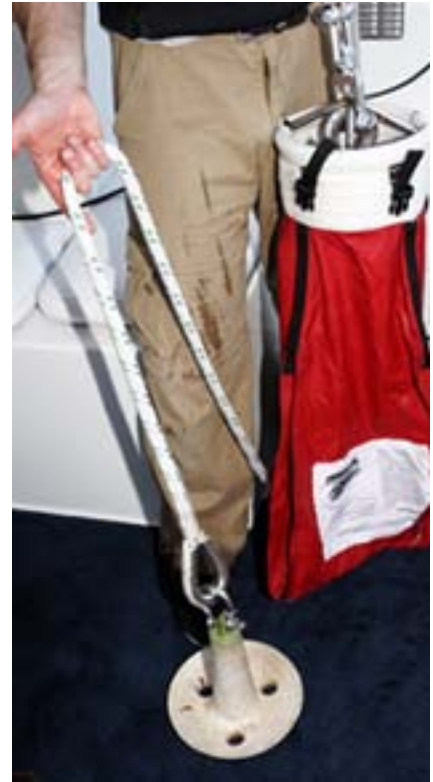
As we towed the drogue behind the catamaran, the one-inch (25 mm) flat rope and the drogue did not wind-up or twist.

Retrieval was time-consuming and exhausting. It required two people to complete the process, even with help from the catamaran's engine. Retrieval was further complicated because the cones tangled around the winch.

Weight Placement: To keep this drogue submerged, weight must be connected at the tail end of the drogue, where there is a small spliced line. The manufacturer recommends 15 to 50 pounds (7 to 23 kg) of weight, dependant on the length of the drogue. Usually, 30 pounds (14 kg) of 3/8-inch (10 mm) chain is the average set-up recommended by the manufacturer.



Shark Drogue



Shark Drogue with Drogue Tail

The lightweight Shark drogue was easy to deploy with the flat rope. As we towed the drogue behind the catamaran, the one-inch (25 mm) flat rope did not wind-up and twist.

The Shark's Para-Ring design permitted its 5/8-inch (16 mm) swivel to spin under force. During the test, the drogue sat right at the surface of the ocean as we towed the device.

Retrieval was easy since the ocean was calm.

Weight Placement: To keep this drogue submerged, chain or a ground anchor must be connected to the Shark's "*Drogue Tail*." The spliced line can accommodate weight up to approximately 50 pounds (23 kg) {At least ten pounds (5 kg) for gale strength weather and 25 pounds (11 kg) for heavy weather conditions.}

To keep things simple, a small ground anchor may be used, as it's something most boaters carry anyway.

DRAG TEST CHARTS



DRAG SPEED CHARACTERISTICS Catamaran Deployment--Single Rode Set-Up

One-inch (25 mm) reel x 30-feet (9 m) webbing, 5,500 lbs. (2,495 kg) break strength on flat rope.

Drogue Brand	48" Delta Drogue by Para-Tech	30" x 36" Galerider	Jordon Series (103 cones)	Small Shark by Fiorentino
Boat speed without drogue (in knots)	N/A	N/A	N/A	7.0
Boat speed with drogue (in knots)	N/A	N/A	N/A	6.3
Speed reduction (in knots)	N/A	N/A	N/A	0.7
Vessel rpm's two propellers	N/A	N/A	N/A	990—port 1032--starboard
Load Cell effect on indicator before drogue deployment	N/A	N/A	N/A	44 lbs. (20 kg)
Load Cell Readout with drogue deployed -- 44 lbs. (20 kg) subtracted	N/A	N/A	N/A	188 lbs. (85 kg)—low 290 lbs. (132 kg)—high 266 lbs. (121 kg)--average
Notes	The Shark drogue's fin was surfacing out of the water too much. Additional scope was payed out to continue the drag tests.			



DRAG SPEED CHARACTERISTICS Catamaran Deployment--Single Rode Set-Up

*One-inch reel (25 mm) x **100-feet (30 m)** webbing, 5,500 lbs. (2,495 kg) break strength on flat rope.*

Drogue Brand	48" Delta Drogue by Para-Tech	30" x 36" Galerider	Jordon Series (103 cones)	Small Shark by Fiorentino
Boat speed without drogue (in knots)	7.0	7.0	7.0	7.0
Boat speed with drogue (in knots)	6.7 to 6.5	6.8 to 6.7	5.4	6.3
Speed reduction (in knots)	0.3 to 0.5	0.2 to 0.3	1.6	0.7
Vessel rpm's with two propellers	1070—port 960--starboard	1000—port 954--starboard	1000—port 960—starboard	1046—port 1000--starboard
Load Cell effect on indicator before drogue deployment	46 lbs. (21 kg)	50 lbs. (23 kg)	42 lbs. (19 kg)	44 lbs. (20 kg)
Load Cell Readout with drogue deployed-- 46, 50, 42, & 44 lbs. subtracted	190 lbs. (86 kg)—low 332 lbs. (151 kg)—high 226 to 286 lbs. (103 to 130 kg)--average	290 lbs. (132 kg)—low 408 lbs. (185 kg)—high 290 to 330 lbs. (132 to 150 kg)--average	582 lbs. (264 kg)—low 870 lbs. (395 kg)—high 658 to 708 lbs. (311 to 321 kg)--average	356 lbs. (161 kg)—low 530 lbs. (240 kg)—high 356 lbs. (161 kg)--average



DRAG SPEED CHARACTERISTICS Catamaran Deployment--Bridle Set-Up

One-inch reel (25 mm) x 100-feet (30 m) webbing, 5,500 lbs. (2,495 kg) break strength on flat rope.

Drogue Brand	48" Delta Drogue by Para-Tech	30" x 36" GaleRider	Jordon Series (103 cones)	Small Shark by Fiorentino
Boat speed without drogue—(in knots)	7.0	7.0	N/A	7.0
Boat speed with drogue—(in knots)	6.4	6.5	N/A	6.1
Speed reduction (in knots)	0.6	0.5	N/A	0.9
Vessel rpm's with two propellers	1060—port 960--starboard	1000—port 960--starboard	N/A	1040—port 1000--starboard
Load Cell effect on indicator before drogue deployment	46 lbs. (21 kg)	50 lbs. (23 kg)	N/A	44 lbs. (20 kg)
Load Cell Readout with drogue deployed-- 46, 50, & 44 lbs subtracted	190 lbs. (86 kg)—low 278 lbs. (126 kg)—high 219 lbs. (99 kg)--average	240 lbs. (109 kg)—low 350 lbs. (159 kg)—high 340 lbs. (154 kg)--average	N/A	356 lbs. (161 kg)--low 382 lbs. (173 kg)—high 356 lbs. (161 kg)--average
*Force reduction with bridle set-up	0 lbs. (0 kg)—low 54 lbs. (24 kg)—high 7 to 67 lbs. (3 to 30 kg)--average	50 lbs. (23 kg)—low 58 lbs. (26 kg)—high -50 to -10 lbs. (-23 to -4 kg)--average	N/A	0 lbs. (0 kg)—low 104 lbs. (47 kg)—high 0 lbs. (0 kg)--average
Notes	* "Force Reduction with Bridle Set-Up" is calculated by subtracting "Load Cell Readout with Drogue Deployed" from both the Single Rode Set-up and Bridle Set-Up charts. The negative numbers (with the Galerider) refers to more force placed on equipment using the bridle versus single-rode deployment. The Series drogue was the last device tested. We chose not to set-up a bridle because there was little force reduction on equipment, with use of the bridle, on the other three drogues.			

CONCLUSION

Data collected in this report, in combination with other technical reports produced by Fiorentino, demonstrate the use of flat rope as a viable option with drogue deployment. Tension load cell readouts reveal that drogues place very little force on cleats, rope, and even upon the drogue itself. (However, Fiorentino suggests multiplying these statistics by four to account for severe weather, as well as potential shock loads where a vessel can unexpectedly lunge forward after a drogue momentarily loses its grip.)

Weight placement on either the drogue or the flat rope can reduce the amount of force placed on boating equipment from shock loading. Weight reduces rope slack and holds the drogue deep enough underwater to allow for maximum drag. (More drag equals a slower boat.)

Weight placement for flat rope deployment with a drogue should be considered a “must,” since the rope usually sits above the water during drag tests. The main reason one-inch (25 mm) flat rope didn’t sink is that it weighs less than 5/8-inch (16 mm) rope by seven-pounds (3 kg) to every 100-feet (30 m).

The one-inch flat rope by Quickline USA is definitely lightweight, but it does still have a potential break force of 5,500 lbs. (2,495 kg). Quickline’s larger flat rope – with a published break-force of 8,000 lbs. (3,629 kg) – might be a safer bet. In our experience, it’s always better to go with a stronger rope, when using a drag device.

The Quickline flat rope offers ease of handling, and a lightweight line that rolls up quickly inside a stainless reel. Quickline’s reel takes up very little storage and can be mounted to a rail or bulkhead for quick access.

To keep the flat rope system easy-to-use with a drogue set-up, we believe weight other than chain should be attached to the drogue. Deploying chain in a real-life storm is very difficult. (Not to mention potential damage to the deck of any boat.) A better option is a drogue tail, which trails behind the Shark drogue, so sailors can attach a spare ground anchor to the drag device. This method permits immediate deployment since weight is concentrated within a small volume of space.

Potentially, a ground anchor could be added to the Jordon series drogue as well. However, the manufacturer should consider a stronger splice with a larger thimble so the line doesn’t part under force. In my opinion, the 1/2-inch (12 mm) splice and light-duty thimble is too risky for the use of a 30 or 50 pound (14 or 30 kg) anchor in heavy weather. The splice should be a 5/8-inch (16 mm) rope with a heavy-duty thimble that is served for extra protection. Another issue is the difficulty in retrieval of the series drogue that can lead to cutting it loose. If you cut your drag device away, then you have nothing for the next weather system.

SECOND FLAT ROPE TEST WITH CHAIN

06-26-08

Most storm drogue manufacturers require a minimum of 15 to 30-feet (5 to 9 m) of chain to sink their drogue below ocean waves. For this reason, a second series of drag tests connecting chain and mushroom anchors to the flat rope was scheduled. All the same equipment from the first drag test (04-04-08) is utilized in this second drag test (06-28-08). The only significant difference is the sea state. Sea state for the first test was one and the sea state for the second test was three.



48-inch Delta Drogue with 3/8-inch (10 mm) chain {23 lbs. (10 kg)}.



30 x 36-inch Galerider Drogue with 3/8-inch (10 mm) chain {10 lbs. (5 kg)}.



Series Drogue with 103 cones and 3/4-inch (19 mm) chain {27 lbs. (12 kg)}.



Small Shark Drogue replaces chain with a mushroom anchor {19.5 lbs. (8.9 kg)}.

DRAG TEST CHARTS (06-26-08)

DRAG SPEED CHARACTERISTICS
Catamaran Deployment--Single Rod Set-Up with Weight

One-inch reel (25 mm) x 100-feet (30 m) webbing, 5,500 lbs. (2,495 kg) break strength on flat rope.

Drogue Brand	48" Delta Drogue by Para-Tech (3/8" chain—23 lbs.) (10 mm chain—10 kg)	30" x 36" Galerider (3/8" chain—10 lbs.) (10 mm chain—5 kg)	Jordon Series (103 cones) (3/4" chain—27 lbs.) (10 mm chain—12 kg)	Small Shark by Fiorentino (19.5 lbs. Mushroom Anchor) (9 kg mushroom anchor)
Boat speed without drogue (in knots)	7.0	7.0 to 7.1	7.0	Average 7.0-- Some initial fluctuation between 6.5 to 7.8 because of 3-foot waves
Boat speed with drogue (in knots)	6.4	6.2 to 6.4 average 6.2	4.7	5.7 to 6.5 average settled into 6.1
Speed reduction (in knots)	0.6	0.6 to 0.9 average 0.8	2.3	0.5 to 1.3 average 0.9
Vessel rpm's with two propellers	1000—port 1007--starboard	1015—port 1005--starboard	1004—port 1000--starboard	1010—port 1020--starboard
Load Cell effect on indicator before drogue deployment	60 lbs. (27 kg)	70 lbs. (32 kg)	66 lbs. (30 kg)	62 lbs. (28 kg)
Load Cell Readout with drogue deployed-- 60, 70, 66, & 62 lbs. subtracted	192 lbs. (87 kg)—low 502 lbs. (228 kg)—high 370 lbs. (168 kg)--average	230 lbs. (104 kg)—low 440 lbs. (200 kg)—high 290 lbs. (132 kg)--average	618 lbs. (280 kg)—low 964 lbs. (437 kg)—high 817 lbs. (370 kg)--average	214 lbs. (97 kg)—low 550 lbs. (250 kg)—high 368 lbs. (167 kg)--average
Notes	<p>Weight: The manufacturer of the series drogue recommends the use of 3/8-inch (10 mm) chain. The 3/8-inch (10 mm) chain is too cumbersome to handle once it's attached to the long rode of cones. To shorten the length of chain, I chose to use 3/4-inch (19 mm) chain for the series drogue test. Amount of weight placed on each drogue is close to manufacturers' recommendations or the common weight placement utilized by end users.</p> <p>Waves: Wave height averaged one to 3-feet (0.31 to 1 m) with occasional 3-1/2 foot (1.1 m) rogue wave sets.</p> <p>Wind: 5.5 to 5.9 mph (5 knots) with gusts up to 8.0 mph (7 knots) during the Shark drogue deployment.</p> <p>Sea State: 3</p>			



DRAG SPEED CHARACTERISTICS Catamaran Deployment--Single Rode Set-Up with Weight

One-inch reel (25 mm) x 180-feet (55 m) webbing, 5,500 lbs. (2,495 kg) break strength on flat rope.

Drogue Brand	48" Delta Drogue by Para-Tech (3/8" chain—23 lbs)	30" x 36" Galerider (3/8" chain—10 lbs)	Jordon Series (103 cones) (3/4" chain--27 lbs)	Small Shark by Fiorentino (3/4" chain--27lbs) (10 mm chain—12 kg)
Boat speed without drogue (in knots)	N/A	N/A	N/A	Average 7.0--
Boat speed with drogue (in knots)	N/A	N/A	N/A	6.2
Speed reduction (in knots)	N/A	N/A	N/A	0.8
Vessel rpm's two Propellers	N/A	N/A	N/A	1007—port 1025--starboard
Load Cell effect on indicator before drogue deployment	N/A	N/A	N/A	62 lbs. (28 kg)
Load Cell Readout with drogue deployed-- 62 lbs. subtracted	N/A	N/A	N/A	118 lbs. (54 kg)—low 250 lbs. (113 kg)—high 138 lbs. (63 kg)--average
Notes	Interesting how the amount of force placed on equipment decreased with a longer length of flat rope. It's also possible the trip line's float pulled up on the 3/4-inch chain to reduce some of the drag that should otherwise be present. It's a guess. Wind, wave and the direction that a boat is steered into these conditions affect drogue behavior as well.			



DRAG SPEED CHARACTERISTICS Catamaran Deployment--Bridle Set-Up with Weight

One-inch reel (25 mm) x 100-feet (30 m) webbing, 5,500 lbs. (2,495 kg) break strength on flat rope.

Drogue Brand	48" Delta Drogue by Para-Tech	30" x 36" GaleRider	Jordon Series (103 cones) (3/4" chain--27 lbs) (10 mm chain--12 kg)	Small Shark by Fiorentino (19.5 lb Mushroom Anchor) (9 kg mushroom anchor)
Boat speed without drogue--(in knots)	N/A	N/A	7.0	7.0
Boat speed with drogue (in knots)	N/A	N/A	4.8 to 4.9	low 5.8 average 6.2
Speed reduction (in knots)	N/A	NA	2.1 to 2.2	low 1.2 average 0.8
Vessel rpm's Two Propellers	N/A	NA	1005--port 1000--starboard	1020--port 1020--starboard
Load Cell effect on indicator before drogue deployment	N/A	N/A	66 lbs. (30 kg)	70 lbs. (32 kg)
Load Cell Readout with drogue deployed-- 66 & 70 lbs. subtracted	N/A	N/A	746 lbs. (338 kg)--low 940 lbs. (426 kg)--high 784 lbs. (356 kg)--average	398 lbs. (181 kg)--low 596 lbs. (270 kg)--high 418 lbs. (190 kg)--average
*Force reduction with bridle set-Up	N/A	N/A	128 lbs. (58 kg)--low 24 lbs. (11 kg)--high 33 lbs. (15 kg)--average	-184 lbs. (-83 kg)--low -46 lbs. (-21 kg)--high -50 lbs. (-23 kg)--average
Notes	* "Force Reduction with Bridle Set-Up" is calculated by subtracting "Load Cell Readout with Drogue Deployed" from both the Single Rode Set-up and Bridle Set-Up charts pages 21-22. The negative numbers (with the Shark) refers to more force placed on equipment using the bridle versus single-rode deployment. There was a set of larger waves that increased measured force. The waves increased measurements by approximately 80 lbs. (36 kg) on average.			

DRAG SPEED CHARACTERISTICS
Position of Drogue in the Wave
Catamaran Deployment--Single Rode Set-Up with Weight

One-inch reel (25 mm) x 100-feet (30 m) webbing, 5,500 lbs. (2,495 kg) break strength on flat rope.

Delta Drogue with 23 Pounds (10 kg) of Chain

Drogue Position	Load Cell Reading	Notes: A noticeable set of waves passed through the drag test that made it easy to record force variations on top of a wave and in the trough. The brief series of waves were approximately 3 ½-feet (1.1 m) in height. Sea state 3.
Top of Wave	462 lbs. (21 kg)	
Trough	290 – 322 lbs. (132 – 146 kg)	
Top of Wave	430 lbs. (195 kg)	
Trough	252 lbs. (114 kg)	
Top of Wave	474 lbs. (215 kg)	
Trough	300 lbs. (136 kg)	
Top of Wave	562 lbs. (255 kg)	
Trough	280 lbs. (127 kg)	

Shark Drogue with 19.5 Pound (9 kg) Mushroom Anchor

Drogue Position	Load Cell Reading	Notes: The brief series of waves were approximately 3 1/2-feet (1.1 m) in height. I only recorded obvious placement of the drogue in the wave or trough. Sea state 3.
Top of Wave	536 lbs. (243 kg)	
Trough	326 lbs. (148 kg)	
Top of Wave	516 lbs. (234 kg)	
Trough	396 lbs. (180 kg)	
Top of Wave	562 lbs. (255 kg)	
Trough	412 lbs. (187 kg)	

DRAG SPEED CHARACTERISTICS
Position of drogue in the Wave
Catamaran Deployment--Single Rode Set-Up with Weight

One-inch reel (25 mm) x 180-feet (55 m) webbing, 5,500 lbs. (2,495 kg) break strength on flat rope.

Shark Drogue with 27 Pounds (12 kg) of Chain + Trip Line

Drogue Position	Load Cell Reading	Notes:
Top of Wave	256 lbs. (116 kg)	
Trough	178 - 180 lbs. (81 – 82 kg)	
Top of Wave	312 lbs. (141 kg)	
Trough	166 lbs. (75 kg)	
Top of Wave	256 lbs. (116 kg)	
Trough	180 lbs. (82 kg)	



DRAG SPEED CHARACTERISTICS COMPARISON
Catamaran Deployment
Single Rode Set-Up (with & without weight)

One-inch reel (25 mm) x 100-feet (30 m) webbing, 5,500 lbs. (2,495 kg) break strength on flat rope.

Drogue Brand	48" Delta Drogue by Para-Tech	30" x 36" Galerider	Jordon Series (103 cones)	Small Shark by Fiorentino
Boat speed reduction with drogue (no weight placement)--in knots 04-04-08 test	0.3 to 0.5	0.2 to 0.3	1.6	0.7
Boat speed reduction with drogue—(weight placement)--in knots 06-26-08 test	0.6	0.6 to 0.9	2.3	0.5 to 1.3
Extra speed reduction because of weight-- (in knots)	0.1 to 0.3	0.3 to 0.7	0.7	-0.2 to 0.6
Notes	The negative number (with the Shark) refers to no change in the reduction of speed with weight added to the drogue. On average, weight placement near each drogue, slowed the catamaran down by approximately 0.5 knots. On average, there was approximately 100 lbs. (45 kg) of extra force placed on equipment with the addition of weight near each drogue.			

Additional Test photographs



Randy Boelsems secures the load cell to a starboard cleat, while your author measures out 100-feet (30 m) of one-inch (25 mm) flat rope for the scheduled drogue drag tests.



Most storm drogue manufacturers require a minimum of 15 to 30-feet (5 to 9 m) of chain to sink their drogues below ocean waves. The Shark drogue is an exception. Weight in the form of a mushroom (or other ground tackle) can be attached to the backside of the drogue to sink it below the waves. Mushroom anchors are the easiest to handle and are cost effective.



Dr. Jim Warner clears the one-inch (25 mm) flat rope from twists before each storm drogue is deployed. This allows us to determine if a drogue actually twists or tangles the flat rope.



10 pounds (5 kg) of chain was not enough weight to hold the Galerider below the surface as we passed through a set of small waves.



The Delta drogue spun out-of-control and was the only drogue that severely twisted Quickline's flat rope.



Dr. Jim Warner and your author review force data after towing each storm drogue behind the 40-foot (12 m) Euphorie Power Catamaran.



Randy Boelsems easily reels in the one-inch (25 mm) flat rope after the last drag test is complete. We videotaped every drag test to help formulate conclusions.

**FPA DRAG TESTS USING 5/8-INCH (16 mm) DEPLOYMENT ROPE
(Charts Taken from Other FPA-Technical Reports)**

Flat rope is much easier to stow and handle than braided rope, but braided rope is much stronger and sinks underwater to create a little extra drag to slow a boat. For these reasons, we felt it relevant for sailors to have the opportunity to compare drag characteristic results from the flat rope tests, to the deployment rode tests. Such comparison permits you to make your own decision between using flat rope or anchor rode with a drogue. The same four drogues, tension load cell, and load cell indicator employed in the flat rope tests were also used to calculate statistics in the following deployment rode tests. Any unusual behavior from a drogue or circumstance surrounding a test is reported in either a “Notes” section in the charts or in the segment titled, “Brief Synopsis.” Some of the Drag Characteristic Charts between various test dates have some subtle differences in layout, since we are continuously developing test procedures for drogue analysis.



DROGUE DRAG TEST WITH DOUBLE BRAID ANCHOR RODE**10-26-2007** (Excerpts from FPA-122)**SPEC. SHEET—CATAMARAN SAILBOAT**

Length (loa):	42' 7-ins (13 m)	Weight:	8.6 tons
Beam:	23' (7 m)	Draft:	3'6-ins. (1.1 m)
Load Cap:	2 tons	Cruising speed:	5 Knots
Fuel Cap:	79 gal	Maximum Speed:	7 Knots Both Engines
Water Cap:	154 gal	Engine HP (each):	Twin 27 Hp

Brief Synopsis

1. Vessel RPM's indicate that currents played a role with vessel speed reduction when drogues were deployed. Catamaran deployments averaged 2,700 RPM's versus Monohull deployments that averaged 2,050 RPM's.
2. On a rare occasion there was a small boat wake during some of the drogue deployments that can affect vessel speed. Typically, one can expect approximately 0.1 to 0.3 knots in vessel speed reduction because of a small wake.

DRAG SPEED CHARACTERISTICS Catamaran Deployment/Retrieval

5/8-inch (16 mm) x 50-feet (15 m) Nylon Double Braid Rode—no weight added

Vessel Speed in Knots	48" Delta drogue by Para-Tech	30" x 36" Galerider	Small Shark by Fiorentino	Jordon Series (103 cones)
Boat Speed without Drogue	6.0 to 6.1	5.8 to 6.0	6.1	6.0
Boat Speed with Drogue	5.3 to 5.4	4.9 low with 5.1 average	5.1 low with 5.2 average	3.7 low with 3.9 average
Vessel RPM's	2,700	2,700	2,700	2,700
Speed Reduction	0.6 to 0.7	0.7 to 1.1	0.9 to 1.0	2.1 to 2.3
Notes	Skipped on surface and could not deploy without vessel slowing.	Easy set. Partially surfaced throughout the deployment.	Creates wake behind drogue.	Retrieval is time consuming.

DRAG SPEED CHARACTERISTICS Catamaran Deployment/Retrieval

5/8-inch (16 mm) x 100-feet (30 m) Nylon Double Braid Rode—no weight added

Vessel Speed in Knots	48" Delta drogue by Para-Tech
Boat Speed without Drogue	6.0 to 6.1
Boat Speed with Drogue	5.1 low with 5.2 average
Vessel RPM's	2,700
Speed Reduction	0.8 to 1.0
Notes	Delta drogue set properly. Back and forth yawing.

DRAG SPEED CHARACTERISTICS Catamaran Deployment/Retrieval

5/8-inch (16 mm) x 150-feet (45 m) Nylon Double Braid Rode—no weight added

Vessel Speed in Knots	48" Delta drogue by Para-Tech
Boat Speed without Drogue	6.0 to 6.1
Boat Speed with Drogue	5.2
Vessel RPM's	2,700
Speed Reduction	0.8 to 0.9
Notes	Set properly, surfaced and yawed Back and forth.

DRAG SPEED CHARACTERISTICS Catamaran Deployment/Retrieval

5/8-inch (16 mm) x 25-feet (7.6 m) Nylon Double Braid Rode—no weight added

Vessel Speed in Knots	Small Shark by Fiorentino
Boat Speed without Drogue	6.0 to 6.1
Boat Speed with Drogue	5.0 low with 5.1 average
Vessel RPM's	2,700
Speed Reduction	0.9 to 1.1
Notes	Para-Ring surfaced rope is too short.

DRAG SPEED CHARACTERISTICS

Catamaran Deployment/Retrieval

*5/8-inch (16 mm) x **25-feet (7.6 m)** Nylon Double Braid Rode—
10-pound (5 kg) mushroom anchor attached to drogue tail*

Vessel Speed in Knots	Small Shark by Fiorentino
Boat Speed without Drogue	6.0 to 6.1
Boat Speed with Drogue	4.9 low with 5.0 average
Vessel RPM's	2,700
Speed Reduction	1.0 to 1.2
Notes	Para-Ring surfaced rope is too short. Some difference in drag with mushroom anchor attached.

DROGUE DRAG TEST WITH DOUBLE BRAID ANCHOR RODE**10-27-2007** (Excerpts from FPA-122)**SPEC. SHEET—MONOHULL SAILBOAT**

Length (loa):	40' (12 m)	Weight:	8.5 tons
Length (wl):	38' 6-in. (11.8 m)	Draft:	6' 4-ins. (2 m)
Beam:	12' 11-ins. (3.7 m)	Cruising speed:	7 knots
Load Cap:	2.5 tons	Maximum Speed:	9 knots
Fuel Cap:	36 gal	Engine HP:	56 HP diesel
Water Cap:	82 gal.		engine

DRAG SPEED CHARACTERISTICS Monohull Deployment/Retrieval

*5/8-inch (16 mm) x **50-feet (15 m)** Nylon Double Braid Rode—no weight added*

Vessel Speed in Knots	30" x 36" GaleRider	Small Shark by Fiorentino
Boat Speed without Drogue	6.0	6.0
Boat Speed with Drogue	4.8 average	4.7 average
Vessel RPM's	2,050	2,100
Speed Reduction	1.2	1.3
Notes		Good wake.

DRAG SPEED CHARACTERISTICS Monohull Deployment/Retrieval

*5/8-inch (16 mm) x **50-feet (15 m)** Nylon Double Braid Rode—no weight added to Shark drogue*

Vessel Speed in Knots	10-pound Mushroom Anchor	Small Shark by Fiorentino
Boat Speed without Drogue	6.0	6.0
Boat Speed with Drogue	5.6 low with 5.7 average	4.5 average
Vessel RPM's	2,050	2,050
Speed Reduction	0.3 to 0.4	1.5
Notes	Sank deep.	Good wake.

DROGUE DRAG TEST WITH DOUBLE BRAID ANCHOR RODE**12-09-2006** (Excerpts from FPA-120)**SPEC. SHEET—MONOHULL SAILBOAT**

Length (loa):	35' (10.7 m)	Weight:	6 tons
Length (wl):	31' 1-in. (9.5 m)	Draft:	5'
Beam: Load Cap:	12'6-ins. (3.8 m)	Cruising speed:	6-7 knots
Fuel Cap:	5 tons	Maximum Speed:	8 knots
Water Cap:	28 gal	Engine HP:	27 HP diesel engine
	120 gal.		

DRAG SPEED CHARACTERISTICS

Monohull Sailboat Deployment—Single Rode Set-Up

5/8-inch (16 mm) x 40-feet (12m) Nylon Double Braid Rode, 15,600 lbs. (7,076 kg) break strength.

	48" Delta Drogue by Para-Tech	30" x 36" Galerider	Jordon Series (103 cones)	Small Shark by Fiorentino
Boat speed without drogue	7.2 knots	7.1 knots	7.2 knots	7.2 knots
Boat speed with drogue	5.5 to 5.6 knots	5.6 to 5.7 knots	3.7 to 3.8 knots	5.3 to 5.4 knots
Load Cell reading (lbs. / kg of force)	104 to 124 lbs. (47 to 56 kg)—average 142 lbs. (64 kg)--high	174 to 206 lbs. (7t to 93 kg)—average 190 lbs. (86 kg)--high	130 to 162 lbs. (59 to 74 kg)—average 190 lbs--high	332 to 368 lbs. (151 to 167 kg)—average 438 lbs--high
Vessel speed reduction because of drogue	1.6 to 1.7 knots	1.4 to 1.5 knots	3.4 to 3.5 knots	1.8 to 1.9 knots
Notes	<p>Delta Drogue: The Delta drogue did not inflate when the sailboat traveled 7.2 knots. It did not open completely until the vessel nearly stopped.</p> <p>Galerider: Deployed as soon as it entered the water.</p> <p>Series Drogue: There was virtually no current inside the harbor by the time we tested the series drogue. This could explain the lower than average force placed on equipment. It took time for the gear to take hold, since it was dumped into the water versus paying it out slowly.</p> <p>Shark Drogue: Deployed as soon as it entered the water.</p>			

DROGUE DRAG TEST WITH DOUBLE BRAID ANCHOR RODE

12-21-2002 (Excerpts from FPA-103)



SPEC. SHEET—COMMERCIAL TRAWLER

Length (loa): 35' (10.7 m)
Length (wl): 33' (10 m)
Beam: 10.5 (3.2 m)
Load Cap: 5 tons
Fuel Cap: 500 gal.
Propellers (1): 24"D x 38"P

Weight: 10 tons
Draft: 5' (1.5 m)
Cruising speed: 6 knots
Maximum speed: 8.5 knots
Engine HP: 65 HP x 2000 RPM

Brief Synopsis

To determine differences in drag capabilities of the drogues, boat speed with a drogue and boat speed without a drogue were subtracted from each other. Because vessel speeds continuously changed on the GPS, a low and high number was recorded for both categories. Consequently, a range of two numbers appears in the mph reduction category of the Low and High Speed Drag Characteristics charts. (1 knot equals 1.151 mph for calculation purpose.)

LOW SPEED DRAG CHARACTERISTICS Monohull Trawler Deployment--Single Rode Set-Up

5/8-inch (16 mm) x **40-feet (12 m)** Nylon Double Braid Rode, 15,600 lbs. (7,076 kg) break strength.

Drogue Brand	48" Para-Tech	30" x 36" Galerider	Jordon Series (103 cones)	Fiorentino Small Shark
Boat Speed With Drogue (mph / knots)	3.7 (3.2 knots) 4.2 (3.7 knots)—high	3.7 (3.2 knots) 4.1 (3.6 knots)--high	N/A	N/A
Recorded Load In lbs. / kg	100 (45 kg) 110 (50 kg)—high	96 (212 kg) 110 (243 kg)--high	N/A	N/A
Boat speed without drogue (mph / knots)	3.7 (3.2 knots) 4.8 (4.2 knots)—high	3.7 (3.2 knots) 4.8 (4.2 knots)--high	N/A	N/A
MPH / knots Reduced because of drogue	0 – 1.1 (0 to 0.95 knots)—low -0.5 – 0.6 (0.4 to 0.5 knots)-high	0 – 1.1 (0 to 0.95 knots)--low -0.4 – 0.6 (0.4 to 0.5 knots)-high	N/A	N/A

HIGH SPEED DRAG CHARACTERISTICS Monohull Trawler Deployment--Single Rode Set-Up

5/8-inch (16 mm) x **40-feet (12 m)** Nylon Double Braid Rode, 15,600 lbs. (7,076 kg) break strength

Drogue Brand	48" Para-Tech	30" x 36" Galerider	Jordon Series (103 cone)	Fiorentino Small Shark
Boat Speed With Drogue (mph / knots)	6.9 (6 knots) 7.8 (6.8 knots)--high	5.8 (5 knots) 6.0 (5.2 knots)--high	3.3 (2.9 knots) 5.1 (4.4 knots)--high	N/A
Recorded Load In lbs. / kg	250 (551 kg) 400 (882 kg)--high	238 (525 kg)--high	196 (89 kg) 224 (102 kg)--high	N/A
Boat speed without drogue (mph / knots)	8.0 (7 knots) 8.2 (7.1 knots)	8.0 (7 knots) 8.2 (7.1 knots)	8.0 (7 knots) 8.2 (7.1 knots)	N/A
MPH / knots Reduced because of drogue	1.1 – 1.3 (0.95 to 1.1 knots)-low 0.3 – 0.5 (0.26 to 0.43 knots)-high	2.2 – 2.4 (1.9 to 2.1 knots)-low 2.0 – 2.2 (1.7 to 1.9 knots)-high	4.7 – 4.9 (4.1 to 4.3 knots)-low 2.9 – 3.1 (2.5 to 2.7 knots)-high	N/A

Notes	<p>Delta Drogue: The Delta drogue did not inflate when the trawler traveled 3.5 mph (3 knots). It did not open completely until the vessel stopped. Vessel speed reduction approximately 0.5 to 1.0 mph (0.43 to 0.87 knots).</p> <p>Galerider: Deployed as soon as it entered the water. Vessel speed reduction approximately 0.5 to 2.5 mph (0.43 to 2.2 knots).</p> <p>Series Drogue: Deployed as soon as it entered the water. Vessel speed reduction approximately 3.0 to 5.0 mph (2.6 to 4.3 knots).</p> <p>Shark Drogue: N/A appears in the column because an older Fiorentino brand was tested, not a Shark drogue.</p>
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RODE DIAMETER AND LENGTH RECOMMENDATIONS

By Drogue Manufacturers

48-inch Delta Drogue by Para-Tech:

Minimum rode size is 1/2--inch (12 mm) with a minimum rode length of 200-feet (61 m). Para-Tech mentions how rode “should be adjusted so the boat and drogue are on the same wave frequency (both in the trough or on the crest at the same time).”

Source: seaanchor.com

30 x 36-inch Galerider:

“The recommended Galerider deployment rode is a double braided nylon line. The minimum recommended length is 350-feet (107 m), and more may be useful under some circumstances. The object is to place the Galerider in the second sea following your vessel and to have enough, but not too much, stretch in the tow line.” They sell both 5/8 and 3/4-inch (16 and 19 mm) rode, but do not explain what diameter of rode goes with what size drogue. In our opinion, the 5/8-inch (16 mm) diameter is all that is required with their 30 x 36-inch drogue.

Source: hathaways.com

103 cone Jordon Series Drogue:

The Series Drogue is connected directly to a cleat located on the stern of a boat. The first part of the drogue is 5/8-inch (16 mm) in diameter and starts with a soft eye splice followed by 88-feet (27 m) of bare line. The second part of the 5/8-inch (16 mm) rode is 45-feet (14 m) long and consists of 28 cones spliced into the rode. Next, two soft eyes are tied together to connect 133-feet (41 m) by 5/8-inch (16 mm) rode to 117-feet (36 m) by 1/2-inch (12 mm) braided, nylon rode. The 1/2-inch (12 mm) line had 75 cones spliced into it. The end of the 1/2-inch (12 mm) rode has a small spliced thimble for weight attachment.

Source: Jordanseriesdrogue.com

Shark Drogue by Fiorentino:

Carry approximately 10-feet (3 m) of rode for every foot (0.31 m) of boat. Use your boat’s WL--waterline or LOA—Length Overall (exclude bowsprits) to determine rode length. Typically, we won’t haul more than 600-feet (183 m) of rode--even if a vessel approaches 100-feet (30 m) in length. Standard deployment rode diameter is 5/8 to 3/4-inch (16 to 19 mm). Fiorentino uses a double braid rode with a Dacron/Nylon mix. Fiorentino prefers to use 5/8-inch (16 mm) rode, regardless of Shark drogue size. Payout enough rode until the drogue is placed on the backside of the wave. If the drogue surfaces, payout more rode until that action stops.

Source: para-anchor.com

ADDITIONAL DRAG TEST RESULTS

12-09-2006 (Concluding excerpts from FPA-120)

These conclusions are based upon engine and boat speed drag comparisons from the Newport Beach test conducted on a 35-foot (11 m) monohull sailboat. To form a more complete analysis of drogues I included information gathered from a second Fiorentino drag test conducted on an 83-foot (25 m) trawler owned by Steve and Linda Dashew.

BUORD—military parachute

Pro: Excellent drogue for large ships because it's very strong and inexpensive. The porous fabric reduces yawing for less rode chafe. The nine-foot buord could work with boats ranging from 100 to 175 feet (30 to 53 m), possibly larger.

Con: Too much drag for smaller vessels. Availability is extremely limited.

Delta Drogue

Pro: The least expensive drogue available on the market.

Pro: Compact for easy retrieval and stowage because it's small. Good for small boats in light wind conditions.

Con: The manufacturer recalled this product due to breakage.

Con: The drogue appears to have a difficult time inflating when a boat travels quickly.

Galerider

Pro: Compact for easy retrieval and storage if folded correctly. Beth Leonard and Evans Starzinger have effectively used a Galerider in a storm with their S/V Hawk.

Con: Starzinger described how the cable on his Galerider broke. Apparently, it also happened to one other couple that he knows. It's possible the cable hoop broke at a weld point when the hoop folded in half when towed. I've observed this type of folding behavior during a Fiorentino tugboat drag test that I conducted in 2003.

Dan Shewmon, author of the *“Sea Anchor & Drogue Handbook,”* conducted his own tugboat drag tests where Shewmon mentions how several Galerider drogues partially collapsed at 8-knots of speed. “The hoop deformation increased as speed was then increased,” said Shewmon.

Still, the Galerider that I tested has not broken and the manufacturer does not disclose any information about this potential issue. One possible solution to avoid breakage could be to add chain to the drogue. The manufacturer doesn't recommend chain, but I definitely think it would be wise to use it, at the very least, use it to create extra drag for slowing your boat in extreme weather.

Con: It can be a challenge to twist the mouth of the Galerider into a figure eight, fold in half, and then place back into its storage bag. Part of the problem is the tendency for the steel cable to spring open with force.

Jordon Series Drogue

Pro: Offers extra holding power that can be good for extreme weather if the drogue is used as a speed-limiting drogue in such situations.

Con: The most difficult to retrieve compared to the other drogues. The problem results from the amount of rode that must be retrieved complicated by the drag created by the cones and required 15 to 50 lbs. (7 to 23 kg) of weight attached at the rope's end. This makes it difficult and time consuming to winch in by hand. A power winch next to *Windhorse's* companionway made retrieval of the Series Drogue easy until the winch overheated and quit. Under most circumstances, I believe it would be extremely difficult to retrieve the Series drogue in semi-rough weather. Rope and cones also present a stowage issue for smaller boats.

Con: Unlike other drogues, the manufacturer's instruction for the use of the Jordon Series drogue is to go down below and allow the vessel to spring forward when struck by waves. This can cause water to sweep the cockpit and slam into the companionway doors. Testimonials supplied by one manufacturer made it clear that vessel damage was likely to occur in a storm. Personally, I would continue to run with the Series drogue if I had to use it in a storm, not passively let a wave hit my boat's stern. To effectively run with a Series drogue you would have to pay out a few cones at a time versus the entire length of line. A task I would think is difficult to achieve.

Fiorentino's Drogue (in 2007 named the Shark)

Pro: The smaller Shark outperforms larger built drogues in slowing boat speed. This fact was supported with the second drag test performed on Steve and Linda Dashews' *Windhorse*, an 83-foot (25 m) trawler that he designed for long distance cruising. Vessel speed was set at 7.0 knots and Fiorentino's 27 by 34-inch drogue slowed *Windhorse* by 1.4 knots. Compare that to Galerider's 48 x 56-inch drogue that slowed the boat by 1.5 knots and a 690-foot (210 m) long Jordon Series drogue that slowed it down by 3.0 knots. (27 x 34-inch drogue is now the Large Shark Drogue.)

Pro: Compact for easy retrieval and stowage because the Para-Ring stabilizer eliminates the need for shroud lines. Additionally, the canopy's solid fabric creates more drag than open fabric because water can't flow through it. More drag equals a smaller unit that takes up less space and is easier to handle. Beth Leonard, author of the "*Voyagers Handbook*," and published author, Evans Starzinger commented on how easy it was to retrieve and pack Fiorentino's drogue in comparison to the Galerider and series drogue deployed from Steve Dashew's vessel.

Con: My goal was to have the option of connecting a second Fiorentino Shark to the drogue tail located on the backside of the primary drogue. The purpose was to increase drag so a sailor can slow their boat enough to handle extreme weather. It turns out that chain attached to Fiorentino's drogue tail is all that is necessary. Chain or a metal anchor attached to the drogue's tail is required for heavy weather only. To see how chain effects drag compare the

24-inch tire drogue tested in tech report FPA-103 with the 24-inch (61 mm) tire tested in this report.

Con: Fiorentino's storm drogue is an improved version that's been on the market since 2002. Early test results demonstrate a strong potential for success with this new drogue. (Update: The Shark is now a proven storm tactic device).

Tire—car or truck

Pro: You can usually pick one up for free. Can serve double duty use as a drogue or fender. You need to add chain to the tire to maximize drag effectiveness and to remove rode slack.

Con: Tires leave black marks everywhere so you'll need a cover for it. Storage might be an issue for smaller cruising boats.

SECOND DROGUE DRAG TEST RESULTS

(Concluding excerpts from FPA-120)



Steve Dashew and your author prepare *Windhorse*, Dashew's 83-foot (25 m) cruising trawler for a simple drogue test. We towed the Fiorentino, Galerider, and Jordon Series drogues to observe how much each device slowed the trawler. The results were surprising.

It took a couple of years for Steve and your author to schedule a time slot to conduct a drag device deployment exercise, but we finally met up on November 26, 2006. We made the decision to practice deploying a 24-foot (7.32 m) Fiorentino para-anchor and later conducted a tow test with a Galerider, Series (stopping drogue), and several Shark drogues from "*Windhorse*," Steve and Linda Dashews' 83-foot (25.3 m) trawler. Beth Leonard and Evans Starzinger were the two reporters invited to observe the test.

In an effort to maintain consistency from previous drag tests that I conducted with Fiorentino and others, I recommended that *Windhorse's* speed be set to 7 knots before deploying each of the three drogues. Everyone agreed. Fiorentino's new Shark drogue at that time performed remarkably well with everyone demonstrating excitement over how compact it was.

PHOTOGRAPHS TAKEN ON SECOND DRAG TEST

By Fiorentino photographer---Mike Munson



Steve and Linda Dashews' *Windhorse*, their 83-foot (25 m) cruising trawler. Photo courtesy of setsail.com.

SPEC. SHEET—WINDHORSE

Length (loa):	83' (25 m)	Weight:	50.12 tons
Length (wl):	81' (24.6 m)	Draft:	5' (1.5 m)
Beam:	17' 8" (5.4 m)	Cruising speed:	11 knots
Fuel Cap:	3,600 gal.	Maximum Speed:	14 knots
Water Cap:	1,975 gal.	Engine HP:	150 per screw
Water Ballast	7,500 lbs	Props (2):	26" D, 5bladed



Steve Dashew and Evans Starzinger (Shark drogue in hand); prepare to launch the Fiorentino Storm Drogue. The goal is to measure how many knots the drogue slows the trawler.



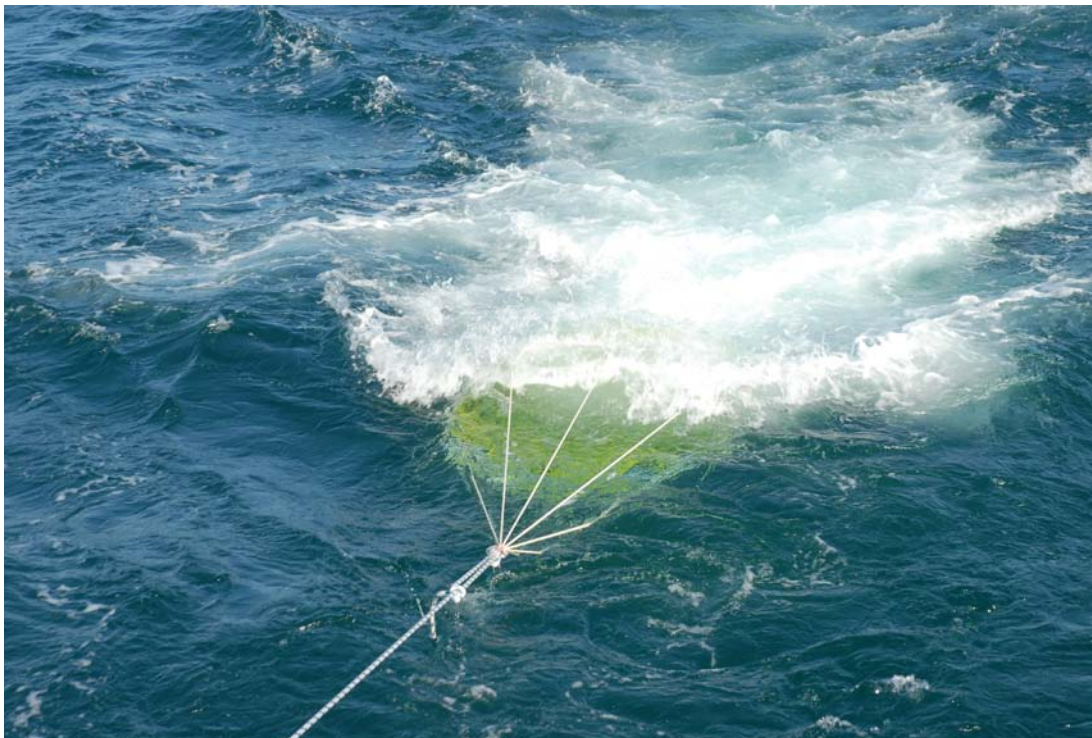
Drag created by Fiorentino's Shark drogue reduced *Windhorse's* speed from 7-knots to 5.6-knots.



The Fiorentino Shark drogue creates a very large wake. Wakes build a barrier that dampen the effect of breaking waves that can flood a cockpit.



Steve Dashew (with drogue in hand); prepares the Galerider for deployment so we can measure how it slows the vessel.



The 48 x 56-inch Galerider slowed *Windhorse*'s speed from 7-knots to 5.5-knots. Only 0.1 difference compared to the 27 x 34-inch Fiorentino drogue. The drogue creates a wake similar to Fiorentino.



It can be a challenge to twist the mouth of the Galerider into a figure eight, fold in half, and then attempt to place it into a small bag. The steel cable continuously springs open with force, as you try to manage shroud lines connected to the hoop.



After completing two drag tests, your author removes the Fiorentino and Galerider drogues to clear space for the final drag test with the Jordan Series drogue. Notice how compact the Shark drogue is compared to the Galerider. Fiorentino is more compact and easier to pack because it has no cables or shroud lines.



The 690-foot Jordan Series drogue slowed *Windhorse*'s speed from 7-knots to 4-knots. 1.6 and 1.5-knots more than *Fiorentino* and *Galerider*. Still, no wake was generated with the enormous amount of rope and cones deployed.



Steve Dashew wraps several cones around his power winch as he begins to retrieve the 690-foot (210 m) Jordan Series drogue. His large electric winch makes it easier to bring in the drogue versus a manual winch located in the cockpit of most sailboats.



After Dashew's electric winch overheats, (from left to right); myself, a crew member, and Evans Starzinger pull in the Jordan Series drogue by hand. Beth Leonard stands to the right with camera at the ready.



Your author stacks the bulky, 690-foot (210 m) long Jordon Series drogue into a circle to avoid tangles. Steve later rinsed the gear with water and took the time to flake it back and forth into its original container.