Surviving Big Storms in Port

Presented at the SSCA Melbourne Gam
November 2012

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http://svsoggypaws.com

ssca.org
SURVIVING BIG STORMS in PORT

• Dave & Sherry McCampbell

• Storm Experience:
  – 16 years aboard
  – Ten hurricanes & one cyclone
  – Three 60 kt surprise storms at anchor

• This presentation at: SVSoggyPaws.com
Soggy Paws
1981 CSY 44
Outline

• Introduction
• Dangerous Storms-Tornados, Cold Fronts, RIM Bombs, Tropical Cyclones
• Finding a Safe Haven
• Preparation & Ground Tackle
• Before, During & After the Storm
• Resources
• Historic Notorious Storms (time permitting)
Storm Survival Issues

• Surviving big storms in port depends on:
  – Adequate preparation
  – Judging storm/wind strength
  – Storm CPA distance/direction
  – Size of storm surge & wave action
  – Avoiding other boats & shore debris
  – Lots of Luck!
Why Attend this Seminar?

• Survey - who’s been in 60 kts?
  – At sea?
  – In port?
• BW cruisers spend 90% time in port
• Weekend cruisers spend 98% time in port
• My 60 knots list
  – At sea - 0
  – In port-15 times!
Soggy Paws Storms

• 1992 Andrew 4 – Homestead AFB/K West, driving
• 1994 Storm Century – Marathon, FL Keys, at home
• 1998 Georges 4 - Shark River FL Eglades, anchor
• 1998 Earl 2 - Marathon, FL Keys, dock
• 2001 Iris 4 - Rio Dulce, Guatemala, river/dock
• 2004 Charley 4 - Shark River, FL Eglades, anchor
• 2005 Dennis 4 – Marathon, FL Keys, mooring
• 2005 Katrina 5 - Key West, FL, in 3D boatyard
• 2005 Rita 5 - Key West, FL, in 3D boatyard
• 2005 Wilma 5 - L Matecumbe, FL Keys, anchor
• 2005 Ivan 5 - Shark River, FL Everglades, anchor
• 2006 Ernesto 1 – L Matecumbe, FL Keys, anchor
• 2012 Cyril 1 – Vavau, Tonga, mooring, dragged
Dangerous Storms

- Tornados/Water Spouts
- Cold Fronts off a Low
- Rapidly Intensifying “Meteorological Bombs”
- Tropical Cyclones
Tornados and Waterspouts

- Tightly wound rotation, small footprint
- Very high winds, 200 kts+
- Fast moving
- Little warning
- Two types waterspouts
  - Summer, under flat based cumulus
  - From tornados ashore
- Move with clouds
Cold Front from Low

- N Hemi – low to N, front trailing to S, comma shape
- S Hemi - opposite
- Preceded up to 300 nm by violent line squalls
- At front - squally wx, sharp wind shift, rapid drop in temp 10-30°F, up to 60 knots winds
- Wind shift N Hemi – E trades, clocking S, NW-N strong 2-4 days, back to trades
- Front extension – often squally weather
- Example – US March ’93 Storm of the Century with winds to 100 knots
Cold Front
1993 Storm of the Century
Rapidly Intensifying Lows/
“Meteorological Bombs”

• Strong extratropical low rapidly intensifies
• Powerful as hurricane
• Baro drops >1 mb/hr for more than 6 hours
• Much larger storm center and wider high wind field than TC
• Examples – ’79 Fastnet, ‘94 Queen’s Birthday, ’98 Sydney Hobart storms
Meteorological Bomb

Recording of wind speed, temperature and atmospheric pressure at the Isle of Shoals Lighthouse station near Portsmouth, N.H., Feb. 22-27. The huge spike in winds that coincided with the spectacular plunge in pressure is similar to observations from a landfalling hurricane. Credit: NOAA/NWS/NDBC.
Meteorological Bomb
1994 Queen's Birthday Storm

June 5, and the low between New Zealand and the Fiji Islands has deepened to 979 mb. It is still squashed against the high to the south, which in turn is still held in place by the stationary depression to the east.

Winds in the dangerous quadrant are estimated at hurricane force. If caught in that part of the storm one should be on port tack, close-hauled. If on the track, or to the west, the wind should be on the port quarter, broad-
1994 Queen’s Birthday Storm

1. Accelerating wind around corner of high.
2. First appearance of the low center.
3. Ridge of the high brings cold air up from south.
4. Dangerous quadrant.
Cyclones, Hurricanes, Typhoons
Tropical Cyclone Formation Requirements

• Coreolis Parameter - must be more than about 5° from equator or won’t spin
• Ocean Thermal Energy - > 26C/83F to 60 meters depth
• Relative Humidity - > 70% up to 18K feet altitude
• Low Vertical Wind Shear - < 25 kts change between lower and upper atmosphere
TC Formation Enhancers

• Inter-Tropical Convergence Zone (ITCZ) on Summer side of equator
• El Nino Southern Oscillation Cycle (ENSO)-
  – In the Pacific where’s the warm water?
  – West - La Nina - more storms in W Pacific
  – East - El Nino - more storms in Mid Pacific
• South Pacific Convergence Zone (SPCZ) in area? (Enhanced squally wx)
• Madden-Julian Oscillation Event (MJO) in area? (Enhanced squally wx, 45 day cycle)
ITCZ & SPCZ
Madden Julian Oscillation

(Brown-wet, green-dry. What?)

http://www.esrl.noaa.gov/psd/MJO/Forecasts
Tropical Cyclone Facts 1

• Summer is TC season
• N hemisphere (S hemisphere opposite)
  – if wind and swell veering, you are in dangerous semi-circle
  – backing in navigable semi-circle
  – steady and falling barometer in path of storm
• N hemisphere dangerous semi-circle location
  – To right facing storm direction
  – Highest winds-wind speed plus speed of travel
  – Highest storm surge
Tropical Cyclone Facts 2

• TC forward travel normally 10-20 knots
• First indicator of TC often long period swells
• Forecast warning error up to 100 nm per day, usually much better
• If TC goes extratropical in higher latitudes:
  – storm spreads out w/ high winds to 500 nm out
  – rate of travel speeds to 50 knots (1200 nm/day)!
SPaws in TC Cyril, Tonga 2012
Buys Ballot’s Law

- **North Hemisphere**
  - CCW circulation
  - Face the wind, storm center will be 115° to **right**

- **South Hemisphere**
  - CW circulation
  - Face the wind, storm center will be 115° to **left**
Storm Surge

Wind and Pressure Components of Hurricane Storm Surge

- Storm motion
- Wind-driven Surge
- Pressure-driven Surge (5% of total)

Water on ocean-side flows away without raising sea level much

As water approaches land it “piles up” creating storm surge

©The COMET Program
Storm Surge/Tide

• Caused by strong winds pushing water toward shore
• Lower central pressure means tighter pressure gradient causing higher winds
• Shallow bay w/ onshore wind enhances effect of surge
• Storm tide is tidal rise plus storm surge
• Effect is slow rise in water level up to 25’+
Storm Surge Danger

- 2012 Sandy, NY/NJ, Cat 1/2, 8-10'
- 2008 Ike, Galveston TX, Cat 3, 15-20'
- 2005 Katrina, N Orleans, Cat 4, 25-28'
- 1995 Opal, Pensacola FL, Cat 3, 24'
- 1989 Hugo, S Carolina, Cat 4, 20'
- 1969 Camille, Mississippi, Cat 5, 24'

- Boats tied to docks have no way to deal with large storm surge
Danger of Staying in a Marina!
# Tropical Cyclone Wind Scales

<table>
<thead>
<tr>
<th>Beaufort Scale</th>
<th>Wind Knots</th>
<th>Hurricanes NE Pac, NW Atl</th>
<th>Typhoons NW Pacific</th>
<th>Cyclones SW Pacific</th>
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<td>Cat 5</td>
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TC Formation Regions

Tropical Cyclone formation regions with mean tracks (courtesy of the NWS JetStream Online School)
World Tropical Storm Paths
TC Frequency Worldwide

Tropical cyclone frequency

Average number of cyclones:
(1980-2000)

- Low
- Moderate
- High

Sources: PREVIEW Global Cyclone Asymmetric Windspeed Profile, UNEP/GRID-Europe.
World Tropical Storm Tracks
Sea Surface Temperatures
N Hemi TC Season
Atlantic Hurricane Formation
North America Major TCs

Major Hurricane History
Data from 1949 in the Pacific, from 1851 in the Atlantic

All North Atlantic and Eastern North Pacific major hurricanes
(at least Category 3 on the Saffir-Simpson Hurricane Scale)
Download high resolution ipo (45 MB)
1972 NW Pacific Typhoons
32 Storms
Monthly Atlantic TC Dispersal
US Hurricane Strike Zones

Total number of hurricane strikes by counties/parishes/boroughs, 1900-2010

Note: When comparing values for counties/parishes/boroughs, differences in geographical size should be considered.
Worldwide TC Centers

- WMO Severe Weather Info Centre
- RSMC - Miami
- RSMC - Tokyo
- RSMC - Nadi Tropical Cyclone Centre
- TCWC - Wellington
- TCWC - Australia
- RSMC - New Delhi
- RSMC - La Reunion
- Canadian Hurricane Centre
Internet Hurricane Resources

- National Hurricane Center-best archives, official tracks [www.nhc.noaa.gov](http://www.nhc.noaa.gov)
- CIMSS Tropical Weather- better storm tracks [www.Tropic.ssec.wisc.edu/#SPECIAL](http://www.Tropic.ssec.wisc.edu/#SPECIAL)
Sample Weather Products
Color Grib

Grib valid: 2011/09/21 00:00 (GFS20110919174601677.grb)

Valid: 2011/09/21 00:00
Cursor: 33°26'S 170°30'W
Wind: 30.2@279 Press: 1006.4
Global Tropical Hazards Outlook

Global Tropical Hazards/Benefits Outlook - Climate Prediction Center

Week 1 - Valid: Nov 14, 2012 - Nov 20, 2012

Week 2 - Valid: Nov 21, 2012 - Nov 27, 2012

Confidence
High Moderate
Tropical Cyclone Formation
Above-average rainfall
Weekly total rainfall in the upper third of the historical range.
Below-average rainfall
Weekly total rainfall in the lower third of the historical range.
Above-normal temperatures
7-day mean temperatures in the upper third of the historical range.
Below-normal temperatures
7-day mean temperatures in the lower third of the historical range.

Produced: 11/13/2012
Forecaster: Pugh

products/precip/CWlink/ghazards/images/ghb_full.png
Spaghetti Track Models
NHC Official Forecast Track
Bopha Forecast Track Error

3 AM JST Wed Nov 28 2012
Position 4.7 N 155.1 E
Maximum Winds 50 mph  Gusts 65 mph
Movement WNW at 4 mph

Circle shows possible storm center locations.
Super Storm Sandy Radar
Enhanced Surface Analysis
Typhoon Bopha Infrared Satellite
Super Storm Sandy Wind Analysis
Super Storm Sandy Grib w/ Wind
Super Storm Sandy Surface Analysis
2005 Atlantic TC Tracks
Fiji Pacific Surface Analysis
Finding a Safe Haven
Ideal Safe Havens

• If must be in hurricane area then look for:
  – All around protection from wind and seas
  – Minimum storm surge issues
  – Strong anchor or mooring possibilities
  – Few other boats/buildings around
  – Wifi or TV and VHF available
  – Secure accommodation options ashore

• Hard to find all above
Safe Haven Options
(in order of preference)

• Out of TC area
• Mangrove creeks
• Enclosed lagoon anchorage
• Strong mooring
• Marginal options:
  – River bank
  – Boat yard
  – Urban canal
  – Marina dock
Out of TC Areas
Mangrove Creeks

- Great option!
- High mangroves negate windage
- Two anchors off bow
- Tie stern to mature mangroves P&S
- Ensure minimum 10’ depth
Enclosed Anchorage

- Look for:
  - < .5nm dia,
  - < 25’ depth,
  - sand or firm mud bottom
  - few other boats
  - 360 degree protection

- Lay 3 point mooring w/ strong ground tackle, details later

• Don’t use tandem anchors
Strong Mooring

- Look for strong anchor and up lines
- Helix screw anchor best, 20K lbs
- **Inspect mooring carefully yourself**
- Watch out for other boats breaking loose
Rivers

• Marginal option if no flooding issues
• Major flooding may send trees, houses, cars, etc downstream
• Debris will upset anchors and clog intakes
• Find protected small bay out of current flow
• Side tie to river bank
• Look for good wind protection
Urban Canals

• Risky option due to below problems
• Ensure adequate depth- at least 10’
• Major problems-
  – Storm surge
  – Other boats
  – Flying debris
  – Hard canal sides
  – Finding strong shore ties
Urban Canals – Katrina 2005
Boat Yards

- Really marginal option in big storms due to increased windage
- Windage–hull, sails, canvas, solar panels
- Domino effect - get away from other boats
- Consider storm surge flooding the yard
- Jack stand strength, chain under boat
- Flying debris problem
- Best option - bury keel into ground
Boat Yards - Charlie 2004
Boat Yards - Ivan 2004
Marinas = Major Damage!

- For strong storms worst option due to storm surge potential
- No solution for short dock line stretch/chafe from big storm surge
- Docks
  - Floating vs static docks
  - Dock hardware strength
- Other problems
  - Unsecured sails & canvas
  - Flying debris
  - Other boats breaking loose
Melbourne YC, Francis, 2004
Melbourne YC, Francis, 2004
Marina Hurricane Damage
Marinas - Katrina 2005
Marina Damage – Ivan/Hugo
Boca Chica Marina, Wilma 2005
Boca Chica Marina, Wilma 2005
Boca Chica Marina, Wilma 2005
Some Relatively Safe Havens
Fla Keys
Shark River
Shark River, Everglades, FL

Mangroves 40’ High
Marathon Harbor, FL Keys
Marathon, FL Keys
Derelict Boat Problem
Lower Matecumbe, FL Keys
Lower Matecumbe, FL Keys
Lower Matecumbe, FL Keys
NW Caribbean

Dangerous Coast

Most Hurricanes
Early Season & Late Season
Isla Mujeres, Yucatan, Mexico
Rio Dulce Entrance, Guatemala
Rio Dulce, Guatemala
Catamaran Marina, Rio Dulce
Calabash Bight, Roatan, Honduras
Calabash Bight, Roatan, Honduras
Eastern & Southern Caribbean
Southwest Pacific

- Pago Pago
- Fulanga I
Eastern South Pacific
Pago Pago, Am Samoa
Neiafu Harbor, Vava'u, Tonga
Vavau, Tonga
Savu Savu, Fiji
Dakuniba, Vanua Levu, Fiji
Ground Tackle

- Anchors
- Moorings
- Shore attachment
- Spreading loads
- Weak links
- Chafe gear
- Line issues
CSY Wind Load Graph

Assumptions: CSY 44 with Wind Resistance (WR) of 243 sq. ft.

Wind Pressure WP = Cd x P/2 x V**2 x WR
Cd = Coefficient of vessel drag...assume 1.1
P = Air density...assume .0034
V = wind velocity
Thus, WP = V**2 x .454(lbs)

Wind pressure is the force on a single anchor (assuming no significant current)

<table>
<thead>
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<th>V</th>
<th>WP</th>
<th>F with a=10</th>
<th>F with a=20</th>
<th>F with a=30</th>
<th>F with a=45</th>
<th>F with a=60</th>
<th>F with a=75</th>
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<td>4434</td>
<td>3975</td>
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</table>

However, if the boat is anchored in Bahamian moor style, with the wind perpendicular to the (imaginary) line between the two anchors, then the force on each anchor is:

\[ F = \frac{WP}{(2\sin a)} \]

If a=0, F is infinite (assuming no rode stretch)

- **Straight line wind pressure only**
- **Must add yaw, pitch & shock**
- **Calder calcs say at least double!**
Finding Ground Tackle Weak Links

- **Chain 3/8”**: SWL
  - BBB/Proof- $5 2650#
  - G4- $5 5400#
  - G7- $10 6600#

- **Shackles**: 2000#
  - 3/8” MS/SS 2000#
  - 7/16” MS/SS 3000#
  - ½” MS/SS 4000#
  - 7/16 G4- $12 5300#
  - 5/8” MS/SS 6500#

- **Swivels**: 3600#
  - ½” MS- $39 3600#
  - 5/8” MS- $58 5200#
  - Kong ½” SS-$240 6600#
Anchoring in 60 Knots

- Good homogenous bottom
- All chain, no weak links
- Strong nylon snubber
- Modern scoop/plow
- Manson/Rocna/Spade/Ultra/Delta
- Boat length ft + weight in Klbs = anchor weight
- Example CSY 44 - 44’ + 40 Klbs = 84 lbs
Ideal Primary Anchor Characteristics

• High relative holding power – minimum Super High Holding Power rating
• Won’t pull out of bottom if drug
• Holds in wide range of sea beds
• High strength design and material
• Always positions itself correctly on bottom for rapid setting
• Superior resetting ability – turns with wind & tide w/o pulling free
• Easy stowage and launching ability
Fisherman/Kedge Anchors-1500s
CQR Anchor - 1933
Danforth Anchor - 1939
(High Tensile)

Danforthanchors.com
Claw/Bruce Anchor – 1970s

westmarine.com

Bruce no longer made
Fortress Anchor

Fortressanchors.com
Bugel/Wasi Anchor - 1984

First of new generation anchors
Delta Anchor - 1986
Lewmar.com

Last of old generation anchors
Super Max Anchor
Creativemarine.com
Spade Anchor - 1996
Spadeanchorusa.com
Rocna Anchor - 2004
Rocna.com
Manson Supreme Anchor – 2006
Manson-marine.co.nz
Manson Ray
Manson Supreme & Ray

The two Manson Anchors products tested were the roll-bar Manson Supreme (left) and Bruce-style Ray (right).
Anchors Wars!

**Manson Supreme**

This is a relatively new anchor, again developed in New Zealand. Figure 6 shows the results for the 7.3kg (15lb) model. Over three runs the normalised UHC was 90kgf, giving a normalised efficiency of 12. This is relatively modest for a newer design anchor, and is also be proportional to the fluke area to the power 1.5, provided that all linear dimensions are kept in proportion. On an area basis then, efficiencies should be.

**Rocna**

EFFICIENCY: 21, 30

The Rocna originates from New Zealand and is designed along similar lines to the Manson Supreme, both having rollbars to encourage initial engagement with the seabed. The plots of DHF and SHF against distance ploughed for 4.1kg (nominally 4kg) and 16.2kg (nominally 15kg) Rocna anchors are shown in Figures 5 and 5A. The normalised UHC of the 4.1kg model is 85kgf and the efficiency is 21. The chart for...
Ultra Anchor 2006
Quickline.us

Made only in SS
Hydrobubble Anchor
azuremarine.com, Out of Business
Bulwagga Anchor
(No longer in production)
Some Anchor Problems
Broken Stainless CQR Knockoff
Bent Shank on Delta

Anchor too small for boat size
Bent Shank on Rocna

Weak Chinese steel?

Bent Shank on CQR
Rusted Through CQR
Corroded CQR, Shackles, Chain
Backwards Swivel, Weak Link
Anchors on test

What is the maximum force an anchor will hold without moving in the seabed? Professor John Knox reveals the results of over 20 years’ research into the holding capacity of different anchor types.
Anchor Testing Results - Voile
2006 Anchor Test Results Sail
2011 Practical Boat Owner

EFFICIENCIES BY NOMINAL SIZES

DATA FROM
Boat Owner 2011 COMPARISON TESTING
2011 Practical Boat Owner
Anchor Research Links

• Rocna Website – Great Anchor Information
  http://www.petersmith.net.nz/boat-anchors/

• Sail-2006 14 Anchor Test, Bill Springer
  http://www.alberg37.org/Project%20DB/2006
  AnchorTest/2006%20IndependentAnchorTes
  t.pdf

• Practical Boat Owner-2011 Test, John Knox
  http://www.roschmarine.nl/images/Download
  Store/prod_20_104.pdf
Anchor Research Links

- West Advisors-Anchor & Mooring Basics 2012
  http://www.westmarine.com/webapp/wcs/stores/servlet/WestAdvisorView?langId=-1&storeId=11151&catalogId=10001&page=West-Advisor-Articles#.UK5EL-Thpdk

- Practical Sailor-Rode Loading Analysis 2012
  http://www.practical-sailor.com/issues/37_17/features/anchor_testing_rode_loads_10784-1.html
Anchor Research Links


Some Other References

- PS May 12-Anchor Testing and Rode Loads
- PS Nov 11-TStorm Do’s & Don’ts
- Bill Springer’s Blog Oct 19 11-Which Anchors Hold Best
- CW Jun 2005-Staying Put: Ground Tackle for a Hurricane
- BWS Sep 2005-Hurricane Warning-Riding Out a Big Blow at Anchor
Anchor Snubbers for Chain Rodes

- **Materials**-
  - Options - nylon, polyester, polypropylene
  - **Nylon** - best strength/stretch combo

- **Types**-
  - Bridle- chafe at chocks, load aft of stem
  - **Bow stem eye**- chafe at chain loop
  - Through bow chocks - chafe
  - **Over anchor roller**- best option, least chafe

- **Connectors**-
  - **Chain hook**- drops off, weak, lose 15%
  - Rolling hitch – knot integrity, chafe
  - Shackle –G4 chain, tight fit pin into link
  - **U plate grabber**- v good, strong/secure
  - **Ultra grabber**- SS, great design, expensive
Snubber Chain Attachments

Samples on front table
Ultra Chain Grab

- Bridge between halves provides strength; Ultra Chain Grab is stronger than chain.
- Round dish prevents catching while Ultra Chain Grab passes through and over the roller.
- Made of 316L stainless steel.
- High strength harp for securing snubber line exerts pull in line with direction of load on chain.
- Spherical dish holds an individual chain link without deforming the link and reducing the breaking strength of the chain.
- Harp length is designed to clear next link to allow release when load is picked up by chain.
- Full opening makes it easy to attach and detach even when chain is under tension.
- Narrowed grab angle prevents catching until required.
SPaws Snubbers

- **Light working snubber** - 5/8” polyester w/ SS chain hook
- **Primary** - single heavy ¾” x 35’ nylon line
- Normal attachment to chain just above water
- Easily adjustable to increase length for storm
- Spliced hard eye at chain end
- U Plate full strength SS chain grabber w/ double ½” SS shackles, (future try Ultra Grabber)
- Rigged over bow roller w/ chafe gear
- Strong bollard attachment on deck
- Backup quickly available
U Plate Snubber Connection
(on bridle)
Swivel

• Must have full strength of chain
• Must be attached to anchor with full strength shackle
• With groove in roller keeps chain from twisting
• Allows turning of big anchor before bringing over roller
SS Kong Swivel
6600# SWL
MS Swivel Improperly Attached

Samples on front table
Moorings
Strong Mooring

- Look for big/strong anchor and up lines
- Helix screw anchor best
- Inspect mooring carefully yourself
- Two up lines for TC use
- Watch out for other boats breaking loose
## Mooring Anchor Strengths

<table>
<thead>
<tr>
<th>Mooring Type</th>
<th>Bottom Condition</th>
<th>Breakout Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>350-lb. Mushroom</td>
<td>5 ft. deep in mud</td>
<td>2,000 lb.</td>
</tr>
<tr>
<td>500-lb. Mushroom</td>
<td>in sand bottom</td>
<td>1,700 lb.</td>
</tr>
<tr>
<td>3,000-lb. Concrete USCG block</td>
<td>set in mud</td>
<td>2,100 lb.</td>
</tr>
<tr>
<td>6,000 lb. cement block</td>
<td>on sand bottom</td>
<td>3,200 lb.</td>
</tr>
<tr>
<td>8/10 Helix</td>
<td>soft clay mud</td>
<td>20,800+ lb.</td>
</tr>
</tbody>
</table>

### Additional Table

<table>
<thead>
<tr>
<th>Mooring Type</th>
<th>Dor-Mor anchor</th>
<th>mushroom</th>
<th>single</th>
<th>double</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helix</td>
<td>650 lbs</td>
<td>500 lbs</td>
<td>2k lbs</td>
<td>8k lbs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resisting Force (lbs.)</th>
<th>Helix</th>
<th>650 lbs</th>
<th>500 lbs</th>
<th>2k lbs</th>
<th>8k lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>12,000</td>
<td>4,500</td>
<td>1,200</td>
<td>800</td>
<td>4,000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Depth</th>
<th>20</th>
<th>18</th>
<th>15</th>
<th>14</th>
<th>35</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Scope</th>
<th>4:1</th>
<th>3:1</th>
<th>3.5:1</th>
<th>3:1</th>
<th>3:1</th>
</tr>
</thead>
</table>
Mooring Attachment Options

- Doubled lines P&S
- Bridle w/ big shackle
- Single line w/ hard eye, shackle
- Multiple lines over bow roller
- Combo-chain, line & shackles
- No-
  - Anchor chain w/ shackle
  - Single line P&S
SPaws Storm Combo Mooring Rig
SPaws Storm Mooring Rig
3 Point Mooring Elements

- 3 big strong anchors
- 3 50’ HT chain legs
- Strong center ring with BIG sentinel weight
- 2 up lines to surface
- Maximize scope
- Chain over roller
- Multiple bow cleats
- Full strength shackles
- No weak links!
Doubled Mooring Lines P&S OK
How Not to Tie to a Mooring
How Not to Tie to a Mooring
Line Considerations

- Nylon vs polyester stretch
  - Nylon 20% stretch @ SWL
  - Polyester 2.4% or less
- Abrasion resistance
- Size- bigger better
- Knot strength-
  - Bowline 60%
  - Buntline hitch 85%
  - Splice 90+% 
- Thimbles on all eyes
Chafe Gear

- Problem-stretch & movement over chocks, cap rail, etc
- **Heat** big issue
- Must ventilate line
  - Use oversize hose
- 1 Rags/towels/tape/etc
- 2 Commercial polyester, rubber, nylon, leather
- 3 Fire Hose
- 4 Heavy PVC hose
- 5 Dacron minimizes stretch/movement
Sails

- RF Headsails - remove, stow below
- Main/mizzen - stow below or strong wrap/tie
- Halyards - run up w/ strong thin lines
Dinghy Storage

• Options-
  – Davits – no, too much windage
  – Ashore – no, theft and debris problems
  – Sunk – maybe if hard dinghy
  – On deck - yes, deflated and well tied down

• Outboard motor - stowed below, windage and theft issue
Shore Attachment Options

- If using line double wrap to minimize movement
- Use buntline hitch not bowline knot
- Use chafe gear
- Consider using short chain around pilings, trees, etc
Before, During & After the Storm
Before the Storm

• Prepare boat
• Load provisions for min 2 weeks
• Top off fuel and water & cash
• Arrange for someone to monitor internet weather for you
• Consider how to communicate with them
• Consider bailout plan if staying on boat
• Don’t count on your dock space being there after the storm
During the Storm

- Get off the boat if above Cat 3, ~100 kts
- Hard to make changes to ground tackle during storm – prepare carefully
- Have goggles and waterproof light ready
- Could us engine to reduce strain on ground tackle or avoid other loose boats
- Leave VHF on Ch 16
- Monitor HF Hurricane Net 14300 USB
After the Storm

• Theft is a big issue – lock everything
• Infrastructure damage ashore
• Lack of provisions/water
• Phone communications a problem
• Sunken debris danger especially in channels
• Transportation difficult
• Plan to be self sufficient for at least 2 weeks
Insurance Issues for Tropical Storms

- May need tropical cyclone zone rider
- Probably no coverage if canvas left up
- No liability coverage if can’t prove negligence - “No Fault Law”
- No coverage if improper maintenance
- Marina insurance?
A Few Good Book Resources

- Nigel Calder - Cruising Handbook
- Beth Leonard - The Voyager’s Handbook
- Earl Hinz - The Complete Book of Anchoring and Mooring
- Don’t believe everything you read especially on the internet!
- Use the eye test to find the truth
HF Hurricane Net

- 14300 USB
- Time
Ultra Chain Grab
Full G4 Strength, Self Release

- May be used to align vessel to waves or weather
- Eliminates noise from anchor chain
- Rubber damper absorbs jerking from anchor chain
- Eliminates strain on windlass and cleats

www.quickline.us
Books

- Most guides
- World Cruising Routes
Southeast US Area

- Coasts
- Gulf Mexico
- Florida W
- Florida Keys
- Florida E
- SE US
VHF Weather

• From NOAA
• No predictions or track info-why?
Southwest Pacific Area
Marinas - Frances 2004
Models

- Sphagetti
- GFS
- Others
Micro Burst
Pacific Tropical Storm Zones

Legend:
1. Hurricanes
   - June - Early November
2. Cyclones
   - Mid November - April
3. Typhoons
   - Can occur throughout the year.
   - Worst months: July - October
   - Lower risk: January - April
World Tropical Storm Zones
Popular Anchor Weaknesses
(As a Primary Anchor)

- **Knockoffs** - weaker materials, degraded performance
- **Fisherman** - very small fluke area, difficult stowage
- **Fluke** types - Danforth, weak design, can’t point load, reset difficulty
- **Shovel** – Max, penetration difficulties in harder bottoms
- **Plow** – CQR, small flukes, wide shank, high knuckle wt
- **Plow** – Delta, stable upside down in soft mud, plow design
- **Claw** – Bruce, basket design, small fluke area, penetration difficulties
- **Modern Scoop** – Spade/Ultra,
- **Modern Scoop w/roll bar** - Manson/Rocna, roll bar can hang up & inhibit deep penetration
Sword/Oceane Anchor
Spadeanchorusa.com
Deck Equipment

• Remove and stow all below:
  • Solar Panels
  • Wind generators
  • Fuel jugs, fenders, BBQs
  • Surfboards, etc
  • Misc deck eqpt
• Remove and stow all below
Cleats and Chocks

• Show open and closed chocks

• Spread the load
• Minimize angle through chocks
• Parallel cleat load
• Strong backing plates
• Closed chocks only
• Good chafe gear
Fenders

- Two types
- Bigger is better
- During storm?
Madden Julian Oscillation Forecast
Literature Findings

- Newer Scoop anchors have much better setting and holding power than CQR/Bruce
- Fluke styles best suited for soft homogeneous bottoms
- Deep diving modern scoop anchors (Rocna/Manson/Spade/Ultra) must have exceptionally strong shanks
- Windage varies with the square of surface area
- Force on boat varies with the square of wind speed
- Max loads on anchor decrease with increased scope
- In 30 kts, shock loads near nil at 10-1 scope
Cockpit Canvas

• Insurance issue for some
• Lightweight bimini & wind screens-remove all and stow below
• Small strong dodger-could leave up if staying onboard and weaker TC
Literature Findings

• Yawing develops significant shock loads on ground tackle
• Reduce yawing with kellet, increased scope, second anchor under foot, riding sail
• Minimize shock loads with long snubber, increased scope and kellet
Moorings

• Anchor
  – Helix screw best – up to 20K lbs strength
  – Concrete blocks - lose ~40% weight underwater
  – Engine blocks – need lots of them
  – Weight – depends on expected wind strength

• Up lines
  – Buoyed chain to start off above anchor
  – Minimum – nylon double dock lines
  – Spliced hard eyes
SPaws Storm Mooring Rig

- On deck - multiple bights polyester/Dacron to multiple cleats
- G4 chain over roller
- Full strength shackles to fit at both chain ends
More here...

http://svsoggypaws.com

http://svsoggypaws.blogspot.com

ssca.org