One Ham's Journey with Antennas

During the 56 years that I have been a ham, I have built and used many antennas. Using ARRL awards as goals, this talk will survey my antennas in Woburn and Harpswell, ME, as I pursued these awards.

Larry Banks, W1DYJ

First licensed: 1962 (KN1VFX)

W1DYJ since 1966 – Amateur Extra

10 Matthews Way Harpswell ME [FN43xs]

33 Blueberry Hill Road Woburn MA [FN42kl]

One Ham's Journey with Antennas

This is not a "How To"…

…it's a "You Can Do It Too"…

Hopefully this talk will get you thinking about your antenna situation!

Larry Banks, W1DYJ

First licensed: 1962 (KN1VFX)

W1DYJ since 1966 – Amateur Extra

10 Matthews Way Harpswell ME [FN43xs]

33 Blueberry Hill Road Woburn MA [FN42kl]

Agenda

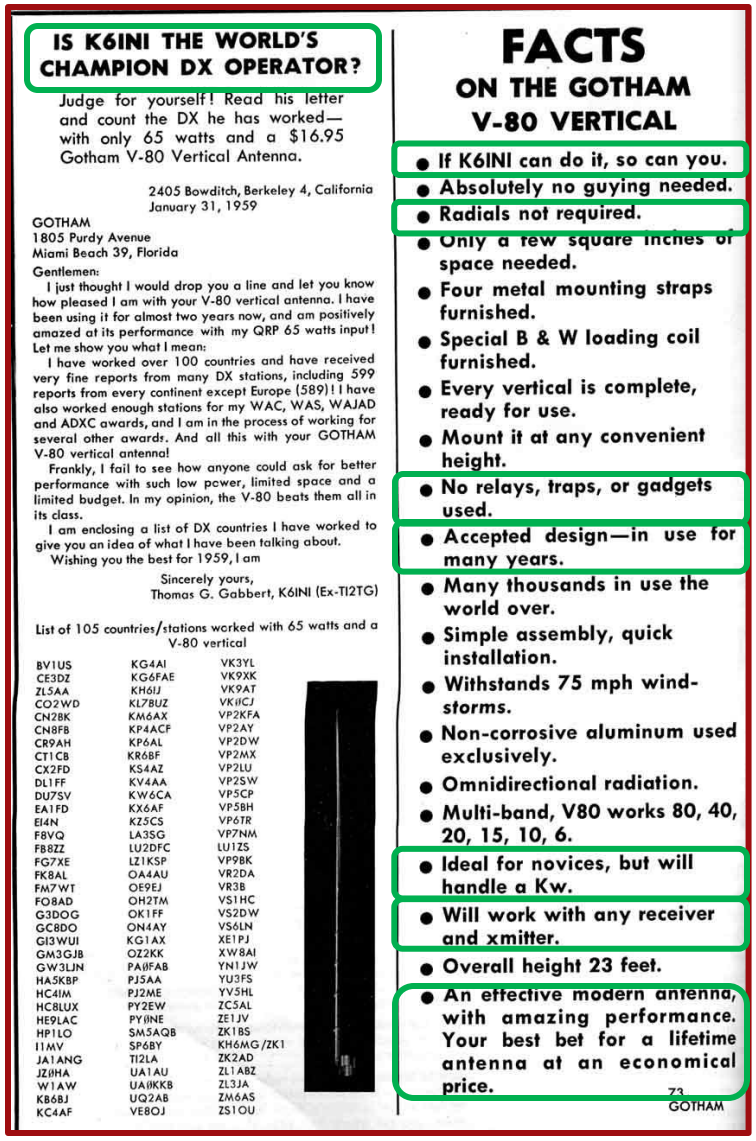
- Some History and Philosophy
- Some Antenna *Rules of Thumb*
- Antennas in Woburn
- Antennas in Harpswell ME
- Playing with FT8
- Playing with 160

Short History

2/1962 – High School – Stratford CT
Novice – KN1VFX

80M Commercial antenna – didn't work!
→ I didn't know why, and my CW skills never jelled because of this!

Stratford CT – 1962 – The Commercial Antenna that did not work



IS K6INI THE WORLD'S CHAMPION DX OPERATOR?

Judge for yourself! Read his letter and count the DX he has worked—with only 65 watts and a $16.95 Gotham V-80 Vertical Antenna.

2405 Bowditch, Berkeley 4, California
January 31, 1959

GOTHAM
1805 Purdy Avenue
Miami Beach 39, Florida

Gentlemen:

I just thought I would drop you a line and let you know how pleased I am with your V-80 vertical antenna. I have been using it for almost two years now, and am positively amazed at its performance with my QRP 65 watts input! Let me show you what I mean:

I have worked over 100 countries and have received very fine reports from many DX stations, including 599 reports from every continent except Europe (589)! I have also worked enough stations for my WAC, WAS, WAJAD and ADXC awards, and I am in the process of working for several other awards. And all this with your GOTHAM V-80 vertical antenna!

Frankly, I fail to see how anyone could ask for better performance with such low power, limited space and a limited budget. In my opinion, the V-80 beats them all in its class.

I am enclosing a list of DX countries I have worked to give you an idea of what I have been talking about.

Wishing you the best for 1959, I am

Sincerely yours,
Thomas G. Gabbert, K6INI (Ex-TI2TG)

List of 105 countries/stations worked with 65 watts and a V-80 vertical

BV1US	KG4AI	VK3YL
CE3DZ	KG6FAE	VK9XK
ZL5AA	KH6IJ	VK9AT
CO2WD	KL7BUZ	VK#CJ
CN2BK	KM6AX	VP2KFA
CN8FB	KP4ACF	VP2AY
CR9AH	KP6AL	VP2DW
CT1CB	KR6BF	VP2MX
CX2FD	KS4AZ	VP2LU
DL1FF	KV4AA	VP2SW
DU7SV	KW6CA	VP5CP
EA1FD	KX6AF	VP5BH
EI4N	KZ5CS	VP6TR
F8VQ	LA3SG	VP7NM
F8BZZ	LU2DFC	LU1ZS
FG7XE	LZ1KSP	VP9BK
FK8AL	OA4AU	VR2DA
FM7WT	OE9EJ	VR3B
FO8AD	OH2TM	VS1HC
G3DOG	OK1FF	VS2DW
GC8DO	ON4AY	VS6LN
GI3WUI	KG1AX	XE1PJ
GM3GJB	OZ2KK	XW8AI
GW3LJN	PA#FAB	YN1JW
HA5KBP	PJ5AA	YU3FS
HC4IM	PJ2ME	YV5HL
HC8LUX	PY2EW	ZC5AL
HE9LAC	PY#NE	ZE1JV
HP1LO	SM5AQB	ZK1BS
I1MV	SP6BY	KH6MG/ZK1
JA1ANG	TI2LA	ZK2AD
JZ#HA	UA1AU	ZL1ABZ
W1AW	UA#KKB	ZL3JA
KB6BJ	UQ2AB	ZM6AS
KC4AF	VE8OJ	ZS1OU

FACTS ON THE GOTHAM V-80 VERTICAL

- If K6INI can do it, so can you.
- Absolutely no guying needed.
- Radials not required.
- Only a few square inches of space needed.
- Four metal mounting straps furnished.
- Special B & W loading coil furnished.
- Every vertical is complete, ready for use.
- Mount it at any convenient height.
- No relays, traps, or gadgets used.
- Accepted design—in use for many years.
- Many thousands in use the world over.
- Simple assembly, quick installation.
- Withstands 75 mph wind-storms.
- Non-corrosive aluminum used exclusively.
- Omnidirectional radiation.
- Multi-band, V80 works 80, 40, 20, 15, 10, 6.
- Ideal for novices, but will handle a Kw.
- Will work with any receiver and xmitter.
- Overall height 23 feet.
- An effective modern antenna, with amazing performance. Your best bet for a lifetime antenna at an economical price.

73
GOTHAM

- New novice KN1VFX
- My first antenna for 80M
- $16.95 was "big bucks" for a sophomore in HS in 1962
  - I knew nothing about antennas
  - Never worked – Best DX was a 40M OO report: "Out of Band"
  - The instructions said radials not required, so I didn't know you really needed them!
  - Have not believed advertisements since!
  - *This experience made me realize that you need to understand the physics of antennas*

A 1962 QST Advertisement

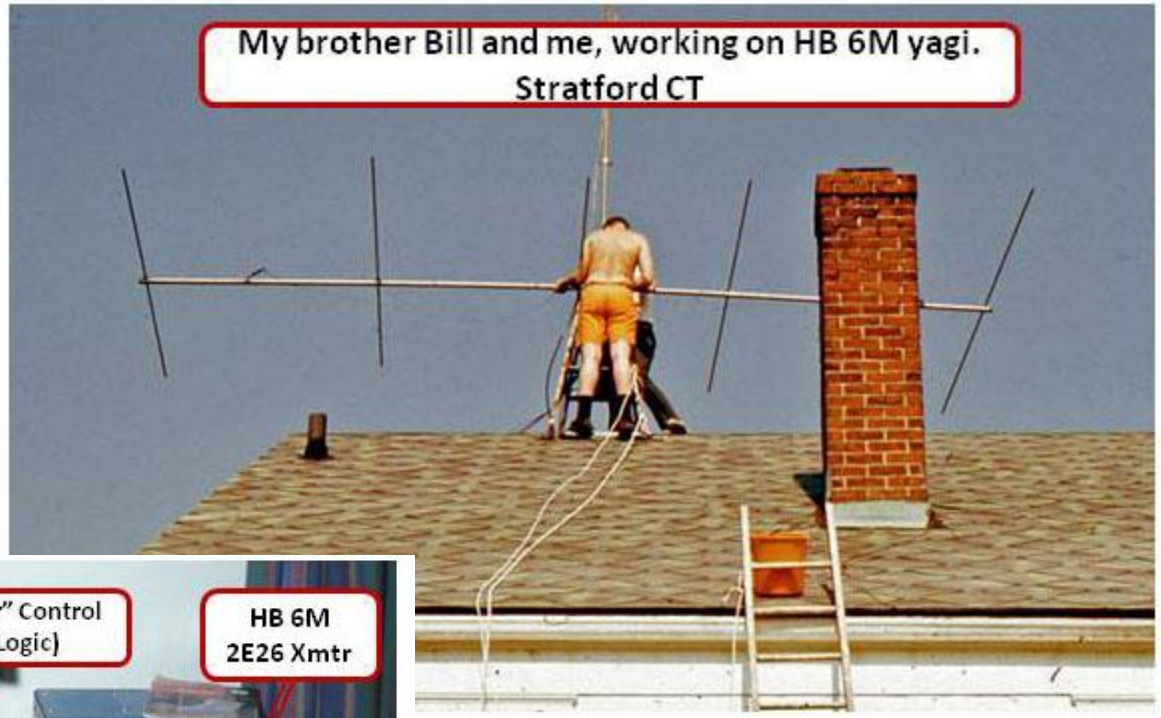
Short History

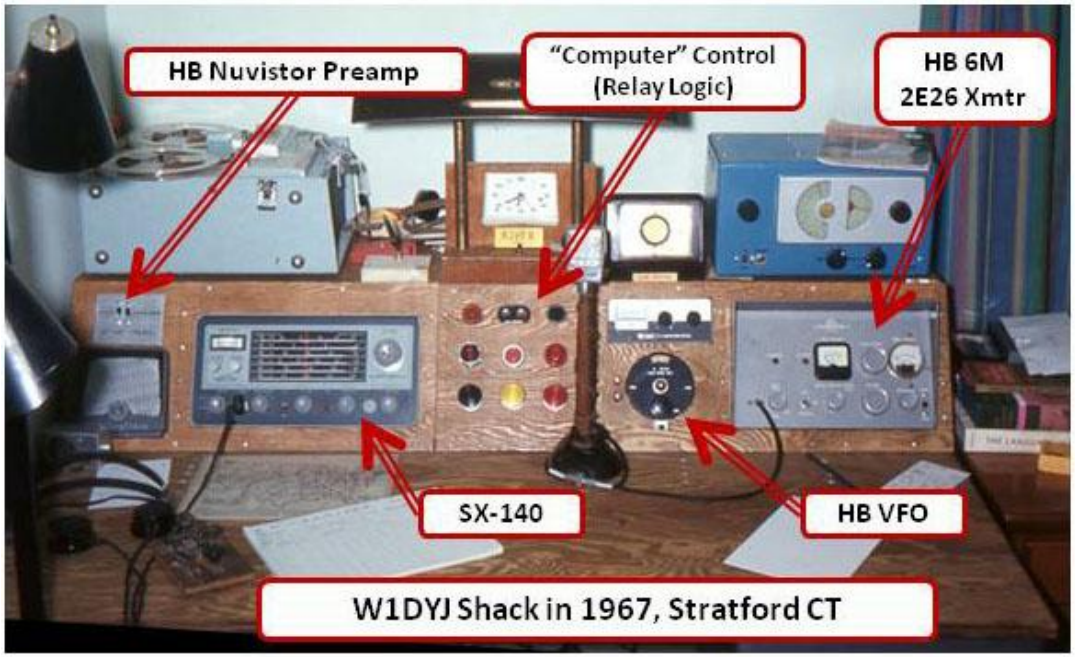
2/1962 – High School – Stratford CT
Novice – KN1VFX / Tech – K1VFX

80M Commercial antenna – didn't work!
→ I didn't know why, and my CW skills never jelled because of this!
6M HB 5 Element Yagi – worked!
→ Led to a need to understand antennas

Stratford CT

The homebrew 6M Yagi that did work!





My "shack" in 1967

Short History

2/1962 – High School – Stratford CT
Novice – KN1VFX / Tech – K1VFX

→ ***80M Commercial antenna – didn't work!***
6M HB 5 Element Yagi-Uda – worked!
→ Led to a need to understand antennas

1969 → Married — no ham radio — Separated → 1993

7/1993 – Apartment
Winchester MA

→ ***10M dipole corner-to-corner in bedroom***
→ Rediscovered Ham Radio

7/1996 – House
Woburn MA

→ ***→ Relearn everything about Ham Radio!***

Remarried 2003

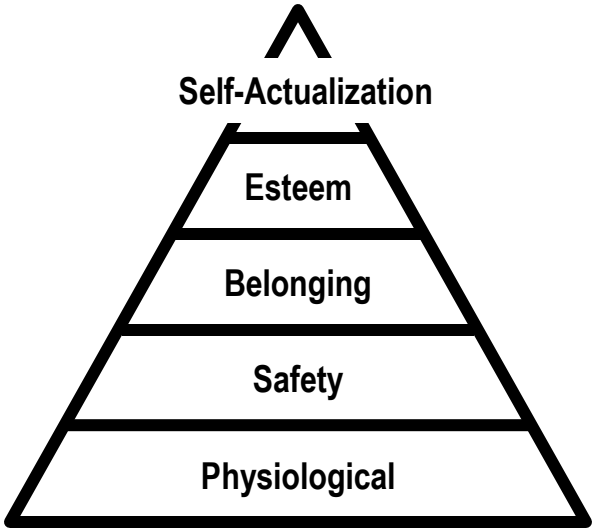
7/2008– 2nd House
Harpswell ME

→ **A chance to *"do it right"***

Retired 2012

My Ham Philosophy

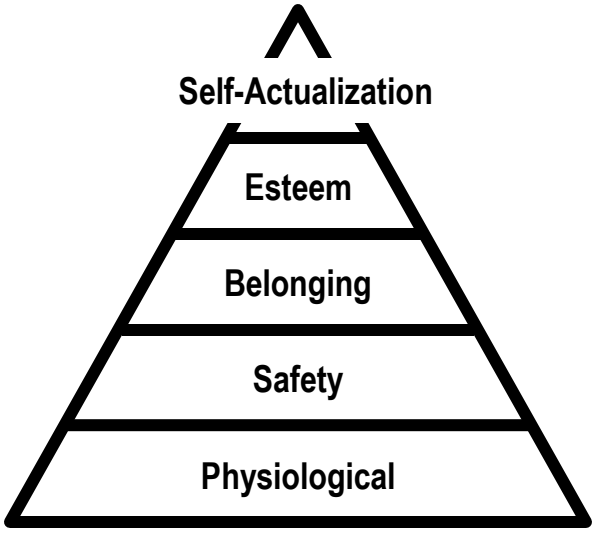
Maslow's Hierarchy of Human Needs



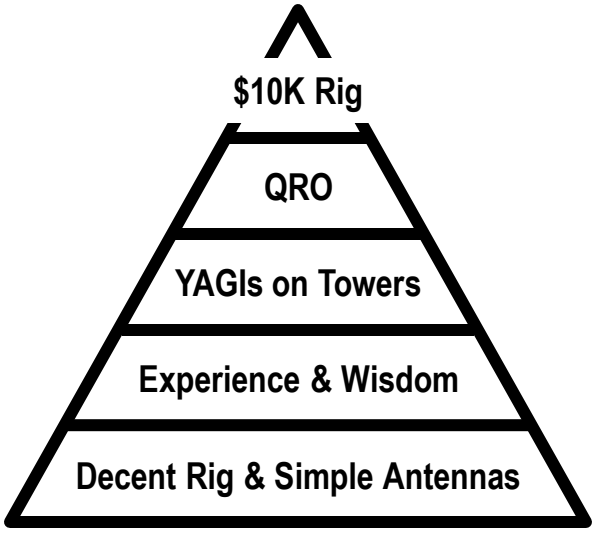
- Reaching one's full potential
- Recognition / Status / Respect
- Friendships / Intimacy / Family
- Health / Financial / Personal
- Food / Water / Clothing / Shelter

My Ham Philosophy

Maslow's Hierarchy of Human Needs

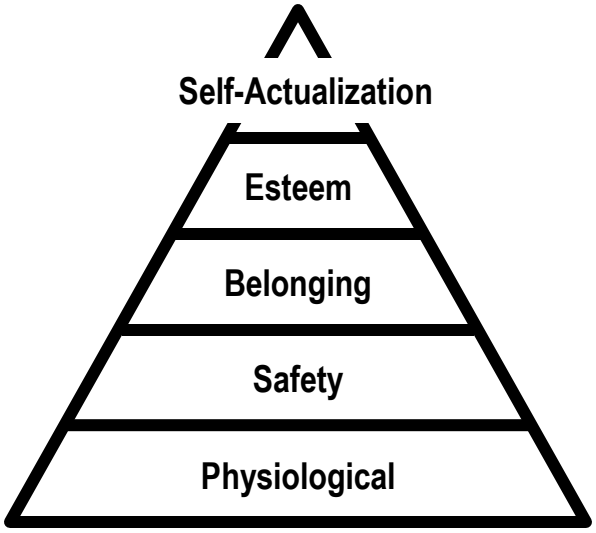


W1DYJ's Hierarchy of Ham Needs

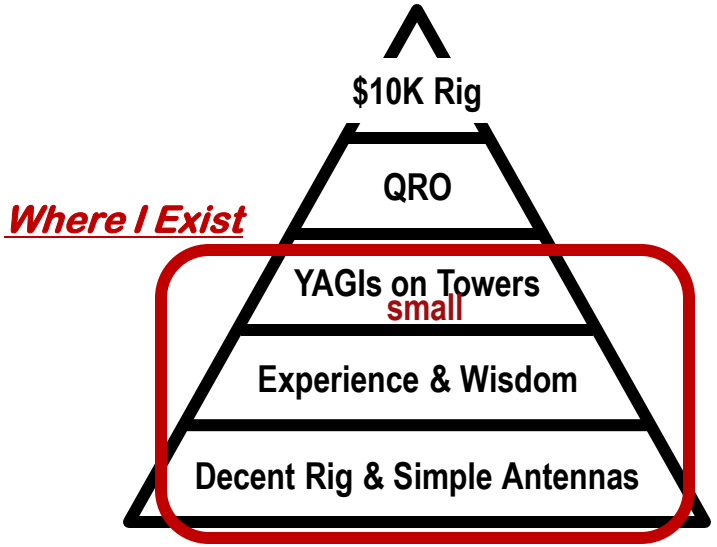


My Ham Philosophy

Maslow's Hierarchy of Human Needs



W1DYJ's Hierarchy of Ham Needs



My Ham Philosophy

- ✓ **Build Stuff → Use It → Make Mistakes**
  - Lots of learning to be done
- ✓ **KISS principle**
  - Do It Myself
- ✓ **Believe in Modeling**
  - Easier than building / rebuilding / rebuilding
- ✓ **Stay Barefoot**
  - QRO doesn't fit the ***KISS principle***
  - QRO doesn't help ***hearing***

Take an engineering approach:

Set Goal → Build Antenna → Results

Goals = ARRL Awards

Not every Ham's cup of tea, but it can be done with simple antennas!

Agenda

- Some History and Philosophy
- **Some Antenna *Rules of Thumb***
- Antennas in Woburn
- Antennas in Harpswell ME
- Playing with FT8
- Playing with 160

Antenna Rules of Thumb – *Length of a Yagi*

10M Antenna in Free Space

[ARRL Antenna Book: 10M Yagi]

n Elements	*Gain ~dBd**
Dipole 0' Boom L	0
2 El – 6' [0.18λ]	4
3 El – 8' [0.24λ]	5
4 El – 14' [0.42λ]	6
5 El – 24' [0.73λ]	8

*0 dBd = 2.15 dBi *0 dBi = -2.15 dBd

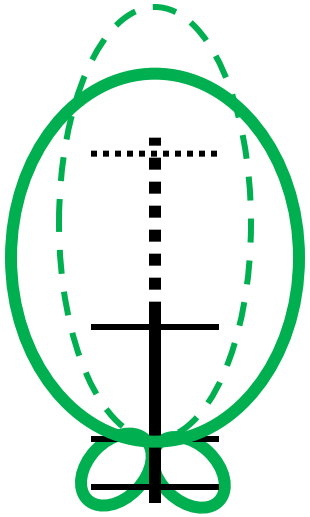
Antenna Rules of Thumb – *Length of a Yagi*

10M Antenna in Free Space

[ARRL Antenna Book: 10M Yagi]

n Elements	*Gain ~dBd**
Dipole 0' Boom L	0
2 El – 6' [0.18λ]	4
3 El – 8' [0.24λ]	5
4 El – 14' [0.42λ]	6
5 El – 24' [0.73λ]	8

*0 dBd = 2.15 dBi *0 dBi = -2.15 dBd



There's really no gain in a Yagi. It's really a "squeezing" of the pattern like a balloon.

More gain, but harder to aim.

In general, boom length x2 → ≤3 dB

[Or stack two yagis for 3 dB.)

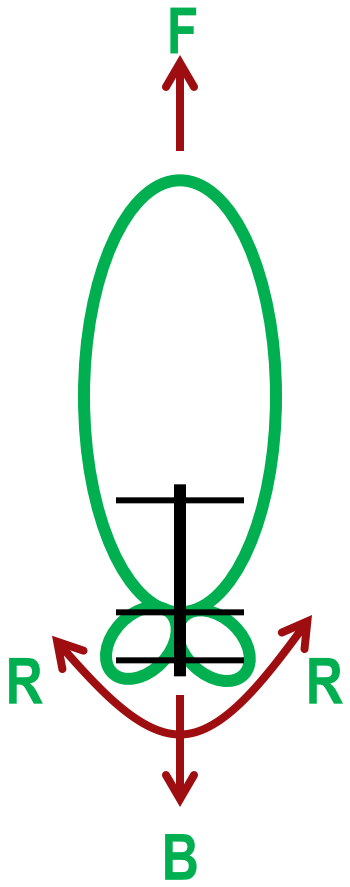
Antenna Rules of Thumb – *Length of a Yagi*

10M Antenna in Free Space

[ARRL Antenna Book: 10M Yagi]

n Elements	*Gain ~dBd**	*~F/R dB*
Dipole 0' Boom L	0	0
2 El – 6' [0.18λ]	4	11
3 El – 8' [0.24λ]	5	22
4 El – 14' [0.42λ]	6	24
5 El – 24' [0.73λ]	8	24

*0 dBd = 2.15 dBi *0 dBi = -2.15 dBd



F/B is deceiving and can be large.
F/R is reality.

Antenna Rules of Thumb – *Length of a Yagi*

10M Antenna in Free Space

[ARRL Antenna Book: 10M Yagi]

n Elements	*Gain ~dBd**	*~F/R dB*
Dipole 0' Boom L	0	0
2 El – 6' [0.18λ]	4	11
3 El – 8' [0.24λ]	5	22
4 El – 14' [0.42λ]	6	24
5 El – 24' [0.73λ]	8	24

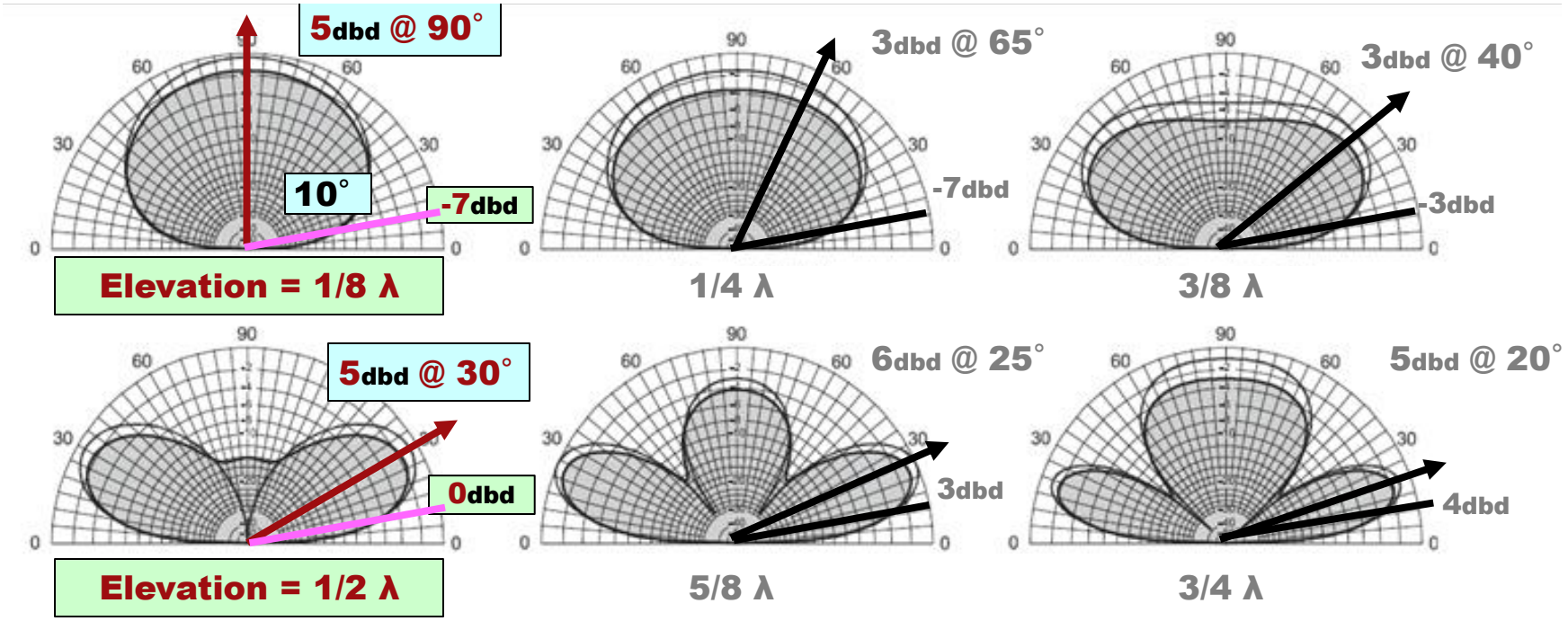
*0 dBd = 2.15 dBi *0 dBi = -2.15 dBd

The "Sweet Spot" for cost, efficacy, and mechanical simplicity

Antenna Rules of Thumb – *Height Above Ground*

Values relative to dipole in free space and for average earth

I use 10° for the default "ideal" DX elevation angle



0 dB on graphs (outer ring) → 7 dBd over free space value

[ARRL Antenna Book: The Effect of Ground]

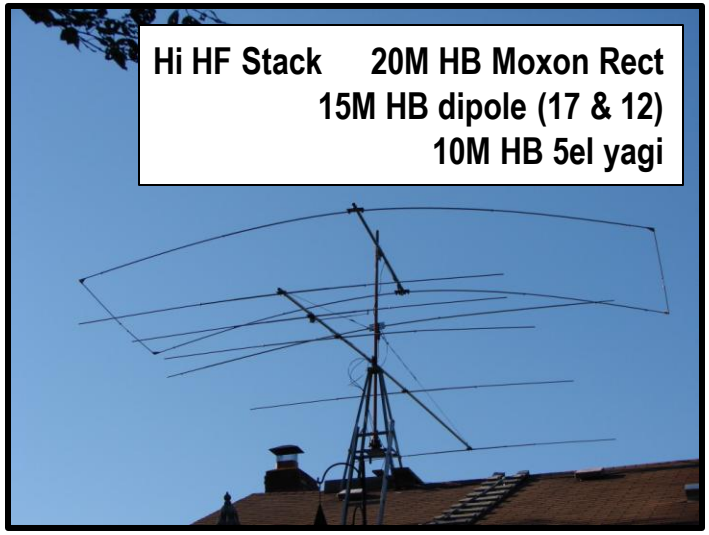
Agenda

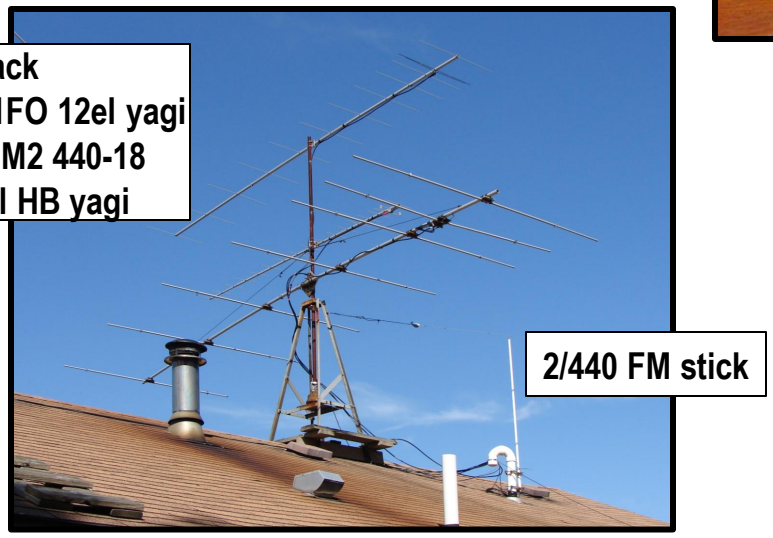
- Some History and Philosophy
- Some Antenna *Rules of Thumb*
- **Antennas in Woburn**
- Antennas in Harpswell ME
- Playing with FT8
- Playing with 160

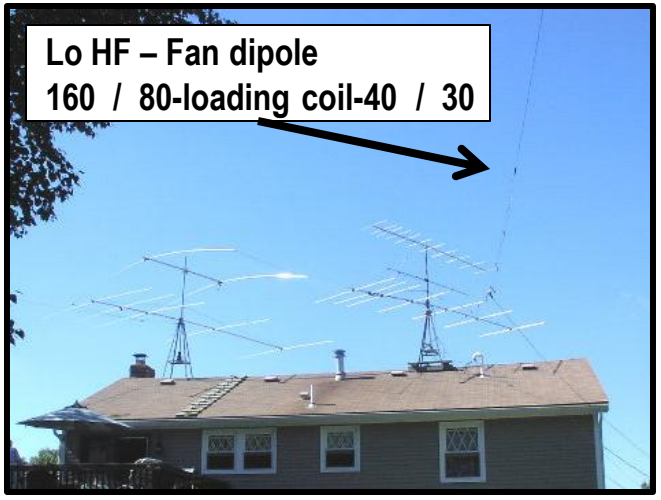
Woburn QTH

Set Goal → Build Antenna → Results

Woburn MA Station





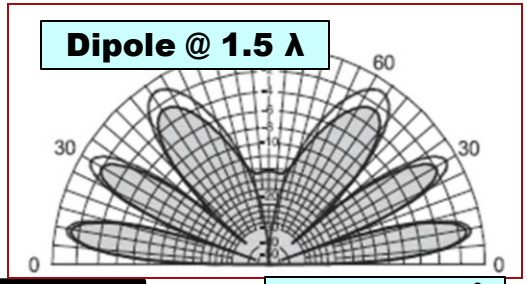


Woburn QTH

Set Goal → Build Antenna → Results

Sept 1998
6M VUCC

HB 7el Yagi ~30ft ~1.5λ
ARRL Design
~9 dBd / >22 dB F/R
[free space]



+ 6 dBd @ 10°

Add the free space ~9 dBd yagi response and the ~6 dBd from the dipole response, and this antenna will have ~15 dBd gain at 10°

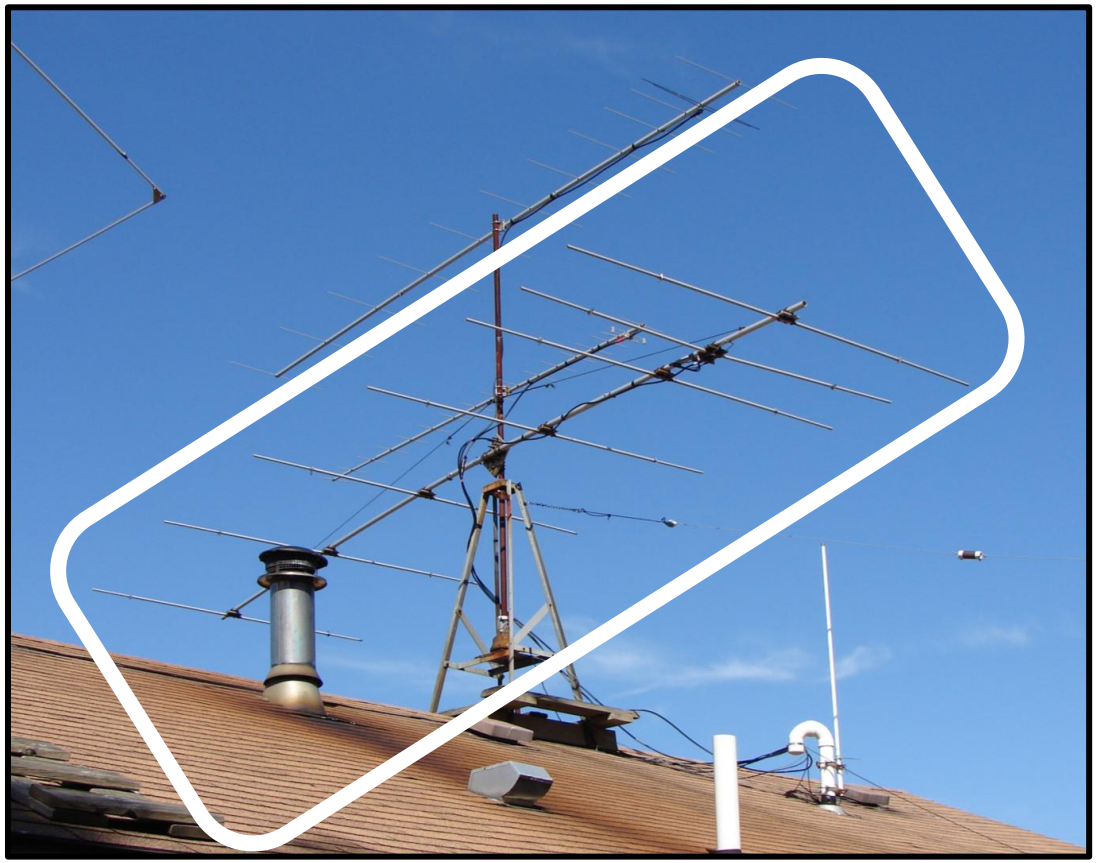
Woburn QTH

Set Goal → Build Antenna → Results

Sept 1998
6M VUCC

HB 7el Yagi ~30ft ~1.5λ
ARRL Design
~9 dBd / >22 dB F/R
[free space]

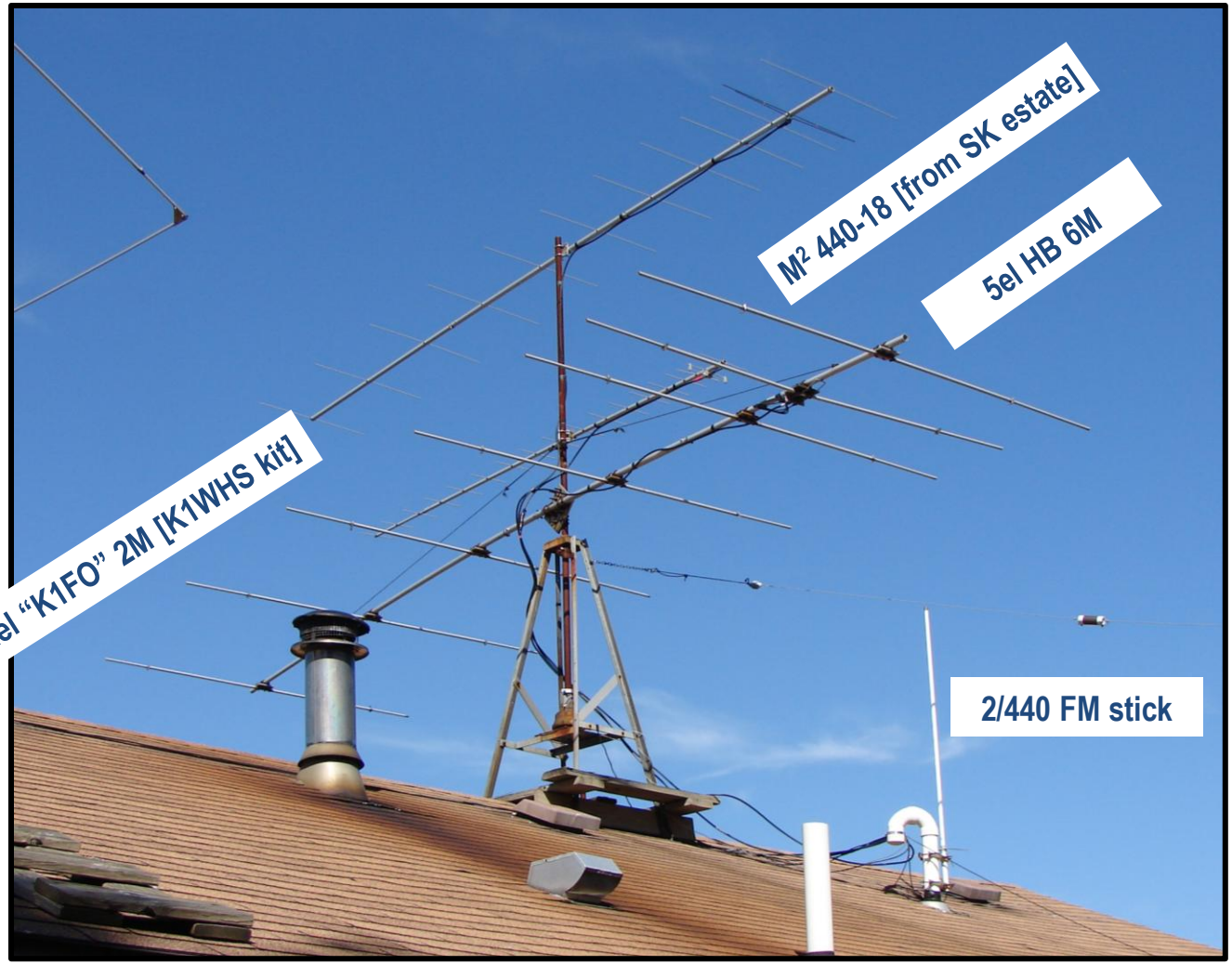
6M VUCC
Aug 2003
36 Countries | 46 States | 307 Grids



Woburn QTH

VHF Contests ~ "SO-3B"

(Just FYI -- not really part of this discussion…)



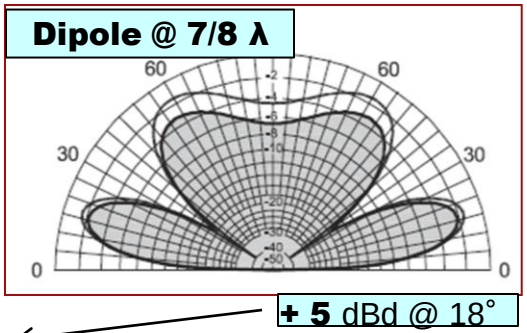
Jan'16	2nd EMA
June '16	3rd EMA
Sept '16	1st EMA
Jan'17	1st NE
using 440 FM	
added 432 yagi	
June '17	1st NE
Sept '17	1st NE
	10th USA
Jan '18	1st EMA
	2nd NE

Woburn QTH

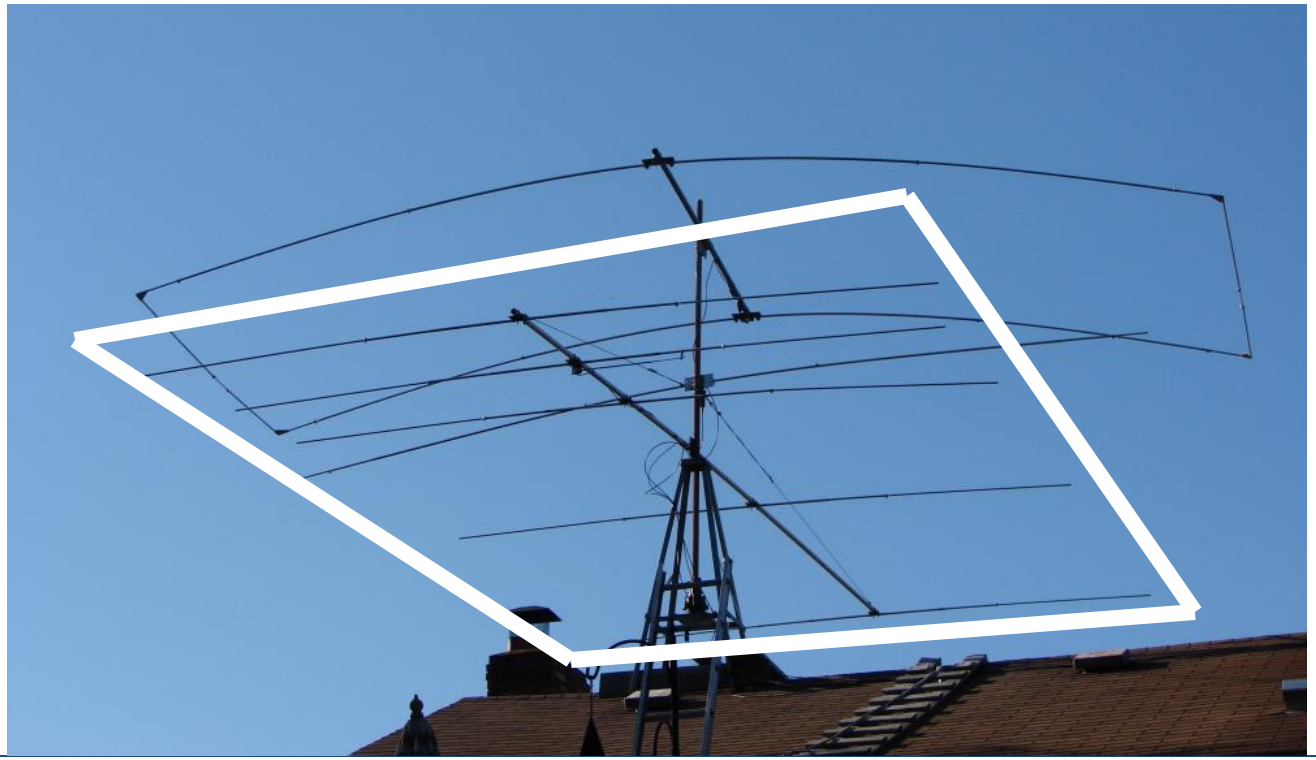
Set Goal → Build Antenna → Results

May 2000
WAS

HB 5el Yagi ~30ft ~0.9λ
ARRL Design
~8 dBd / >24 dB F/R
[free space]



~13 dBd

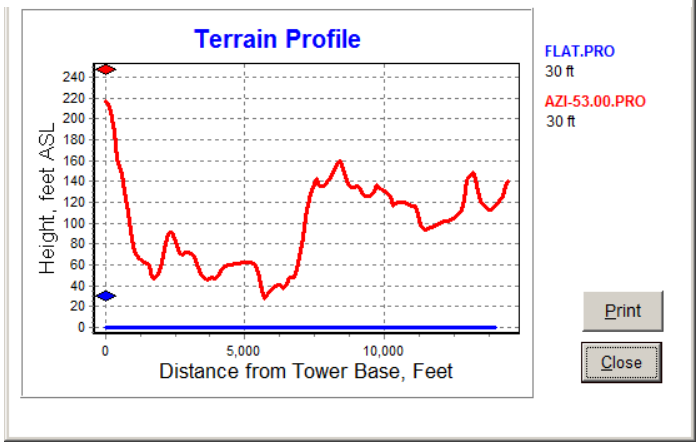


Woburn QTH

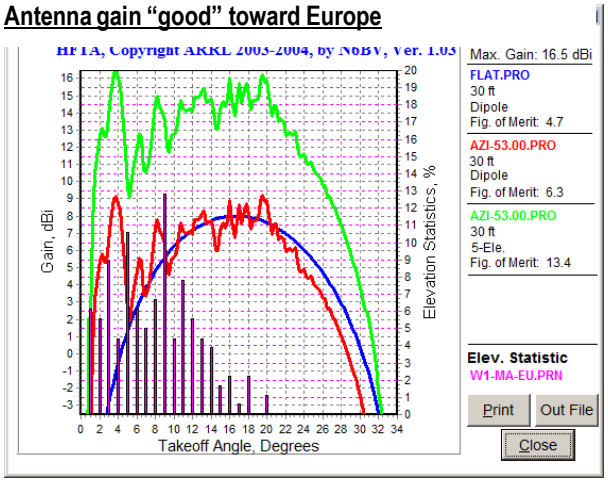
Set Goal → Build Antenna → Results

53° England

Antenna on the "front" of the hill

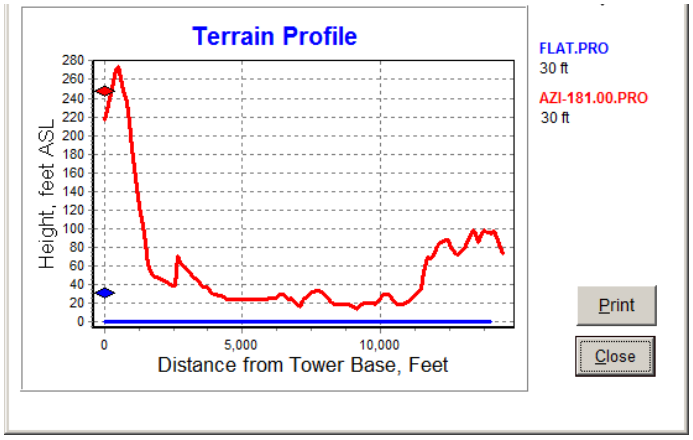


Antenna gain "good" toward Europe

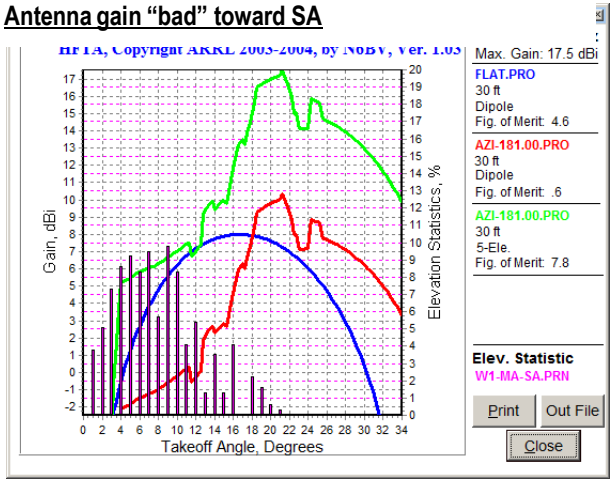


181° Chile

Antenna on the "back" of the hill



Antenna gain "bad" toward SA



HFTA: 5 el 10M Yagi @ 30'

HFTA (High Frequency Terrain Analysis) is another VERY useful antenna modeling software package. It is included in the ARRL Antenna book.

My "hill" in Woburn slopes off toward Europe. HFTA is *beyond the scope* of this discussion, but these graphs show how my 10M yagi is MUCH BETTER toward Europe than toward South America, due to the terrain.

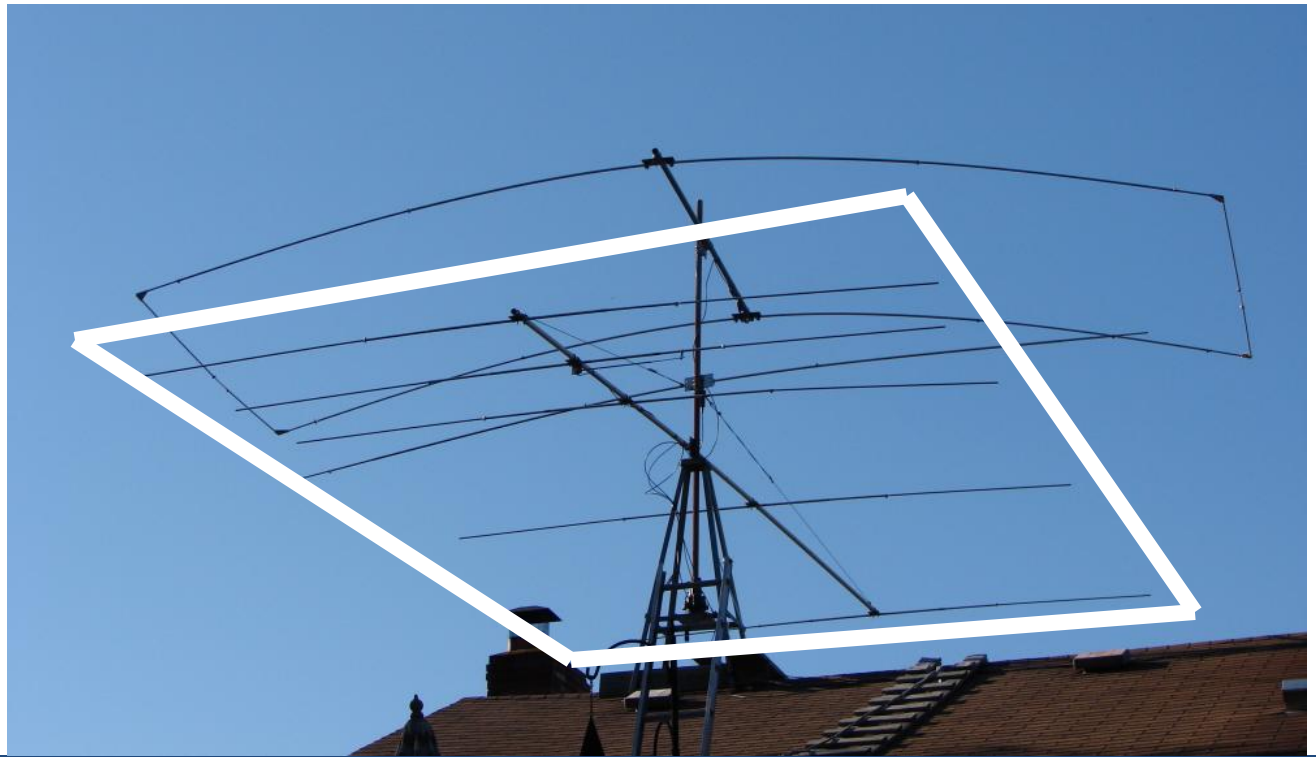
Woburn QTH

Set Goal → Build Antenna → Results

May 2000
WAS

HB 5el Yagi ~30ft ~0.9λ
ARRL Design
~8 dBd / >24 dB F/R
[free space]

10M PH WAS
Jan 2004



Woburn QTH

Extra – 7/2000

May 2001
DXCC

Set Goal → Build Antenna → Results

Alpha-Delta DX-CC ~ 20ft

vs. FrSp dBd @ 10°

80M	~0.08λ	> -15	40M	~0.15λ	~ -13
20M	~0.3λ	~ -10	15M	~0.4λ	~ - 8

Woburn QTH

Extra – 7/2000

May 2001
DXCC

Set Goal → Build Antenna → Results

Alpha-Delta DX-CC ~ 20ft

vs. FrSp dBd @ 10°

80M	~0.08λ	> -15	40M	~0.15λ	~ -13
20M	~0.3λ	~ -10	15M	~0.4λ	~ - 8

PH DXCC
Nov 2009

Woburn QTH

Set Goal → Build Antenna → Results

August 2004
20M DXCC
& contesting

HB Moxon ~36ft ~0.5λ
W1DYJ Mechanical Design
~8 dBd / 15dB F/R [@ 26°]

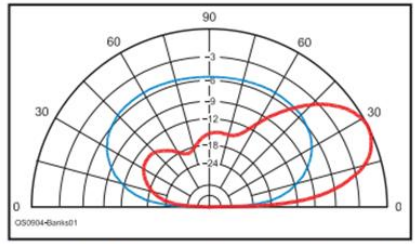


Figure 1 — A comparison of the lower radiation angle and greater gain of the Moxon (red) compared to the dipole (blue).

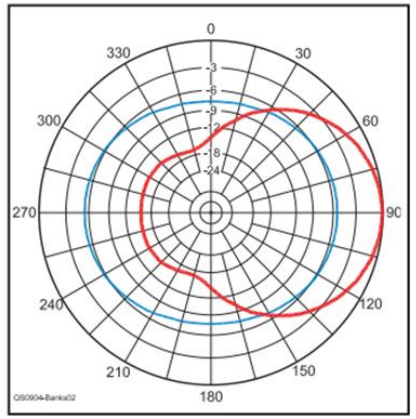


Figure 2 — This shows the superior front-to-back and greater gain of the Moxon (red) compared to the dipole (blue). Both plots are at the Moxon maximum radiation angle of 26° elevation.

Woburn QTH

Set Goal → Build Antenna → Results

August 2004
20M DXCC

HB Moxon ~36ft ~0.5λ
W1DYJ Mechanical Design
~8 dBd / 15dB F/R [@ 26°]

20M DXCC Jan 2013

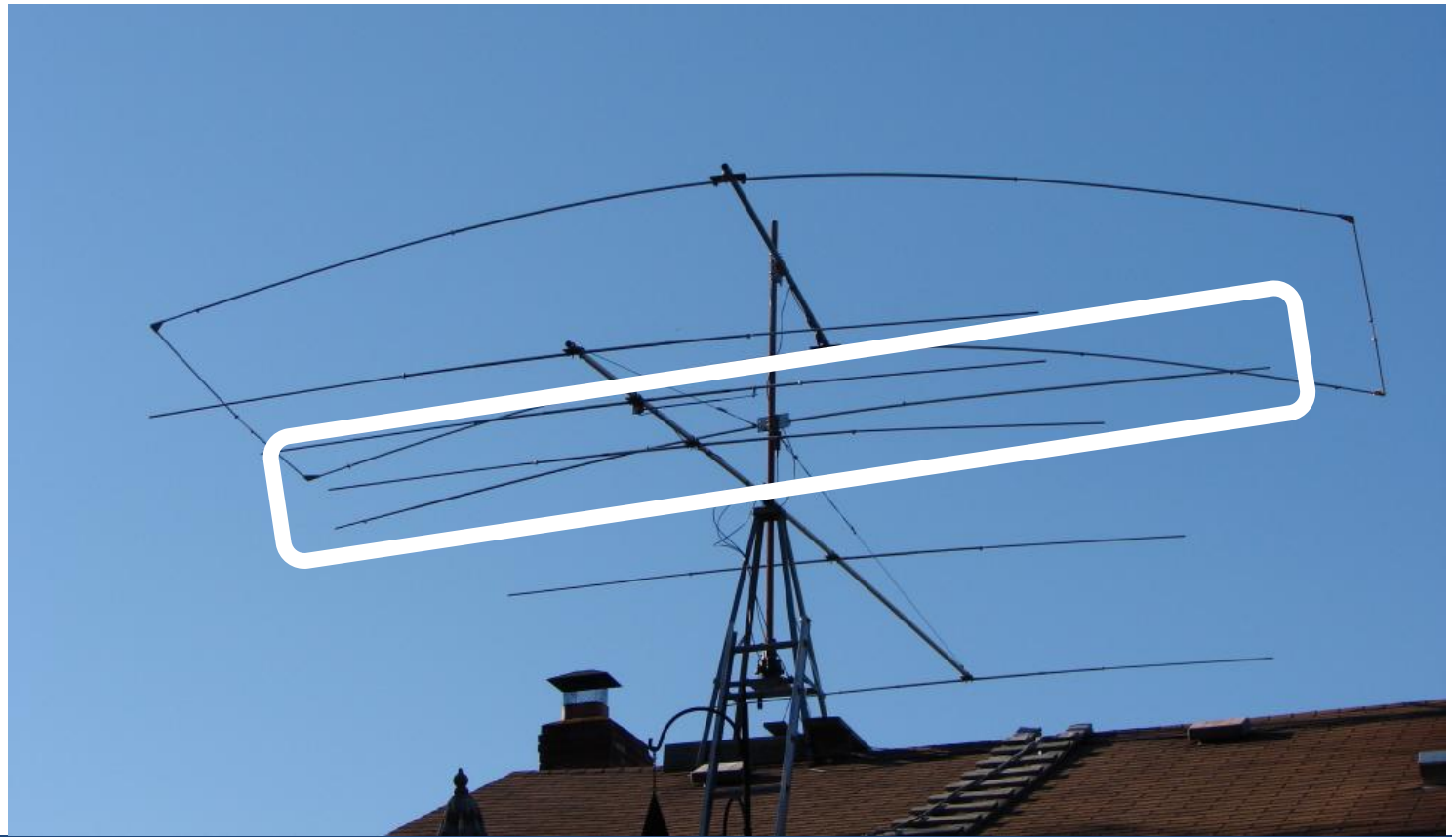
QST 4/2009 – Winner of the QST Cover Plaque Award
Also in ARRL Antenna Compendium Vol. 8
and the Supplemental Files CD of the ARRL Antenna Book, 23rd edition.

Woburn QTH

Set Goal → Build Antenna → Results

April 2011
15M DXCC

HB Rotatable Dipole ~33ft ~0.7λ
~ -2 dBd @ 20°



Woburn QTH

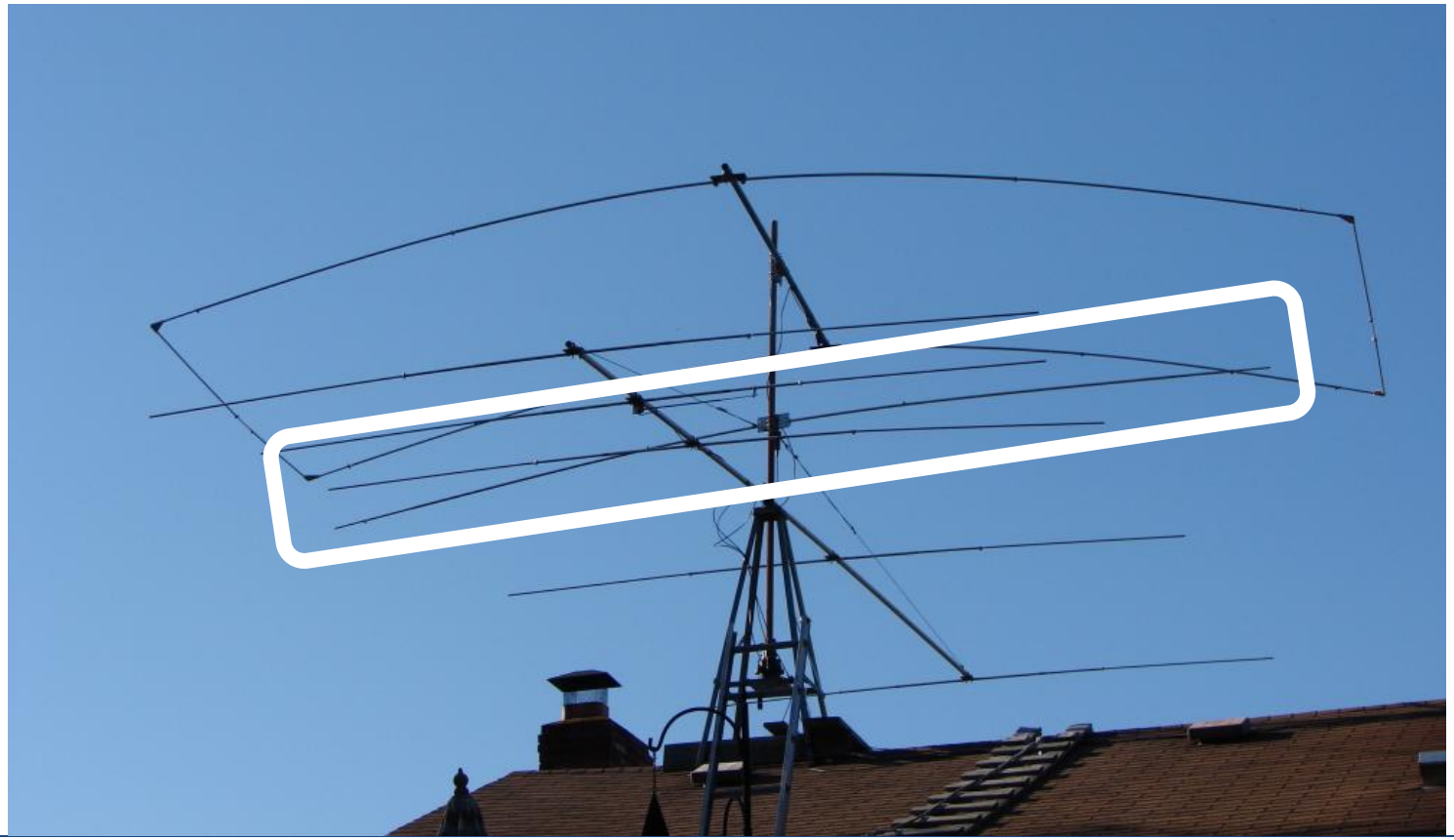
Set Goal → Build Antenna → Results

April 2011
15M DXCC

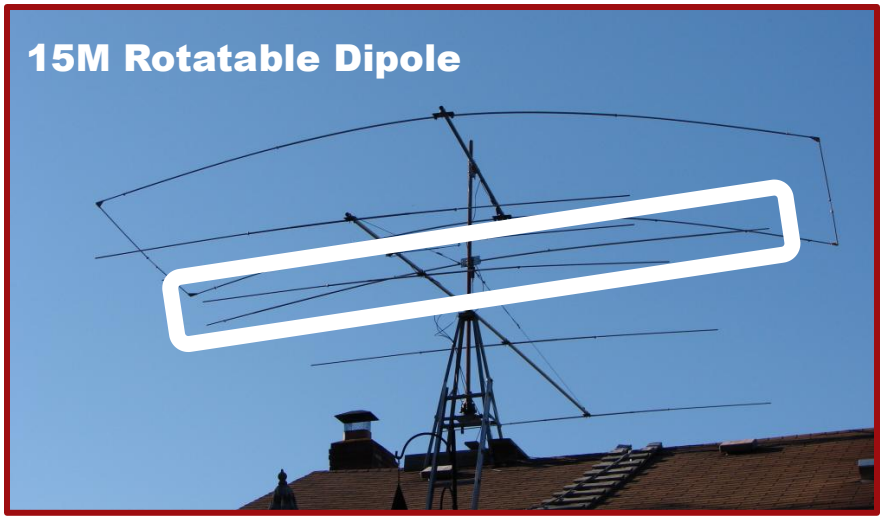
HB Rotatable Dipole ~33ft ~0.7λ
~ -2 dBd @ 20°

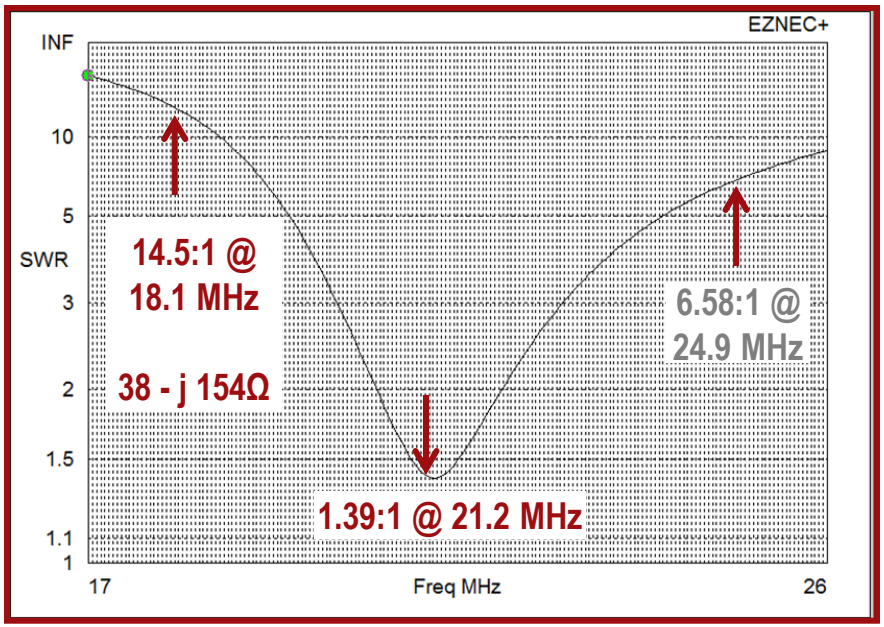
Also use on 17M & 12M

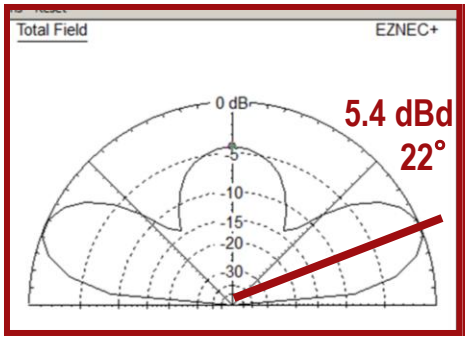
15M DXCC
April 2014

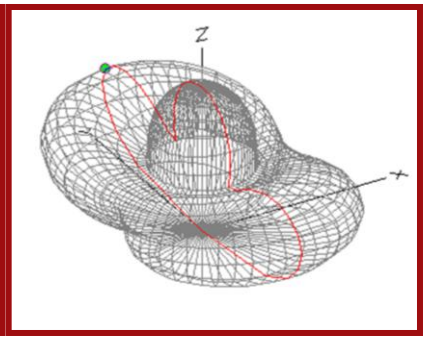


Woburn QTH Also 17M





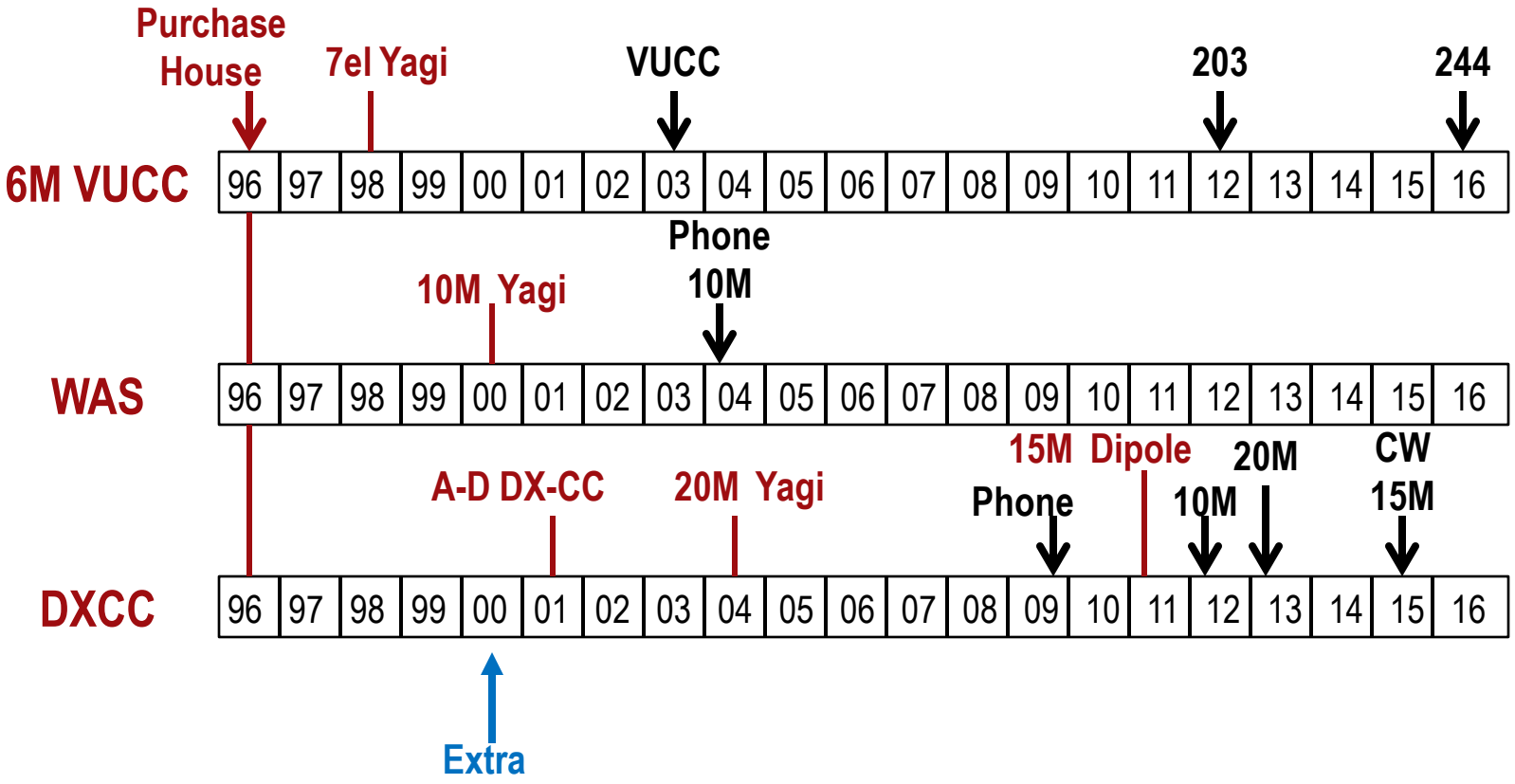




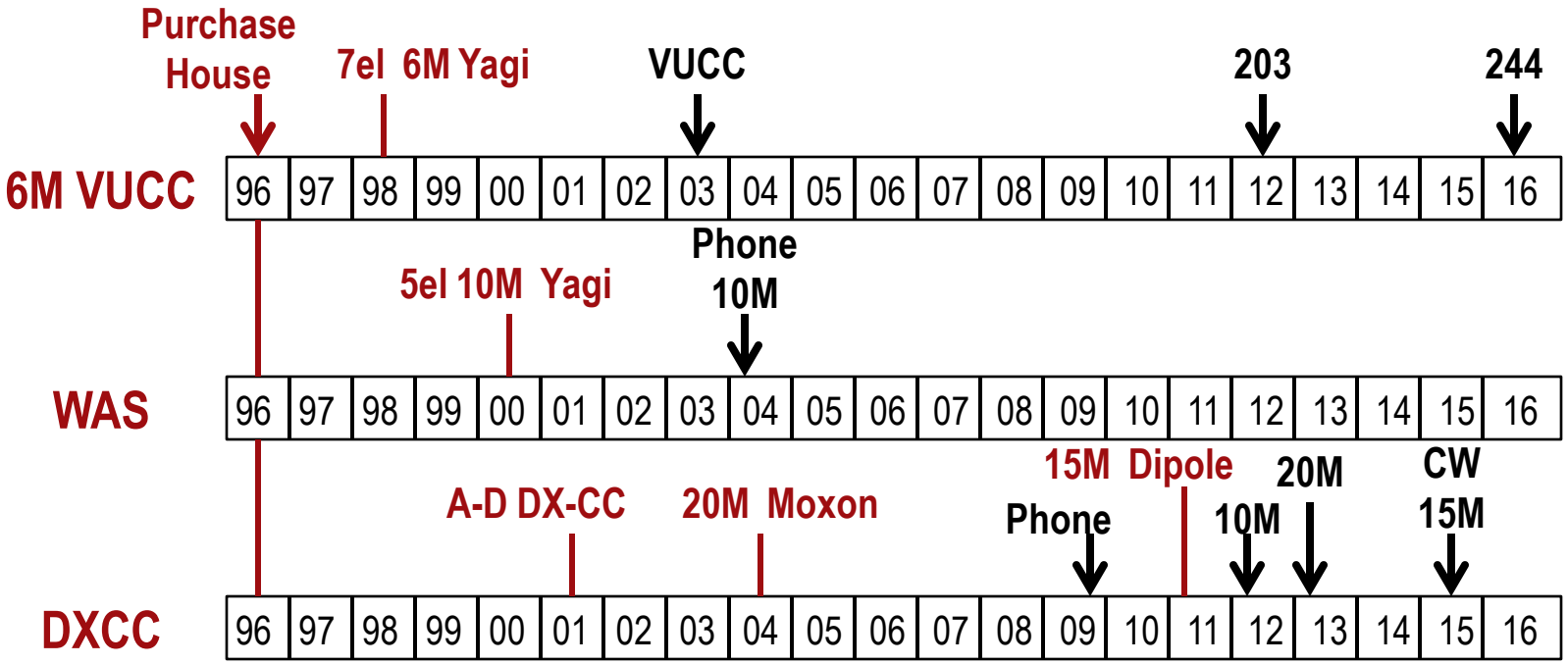
From TLW [Z= 38 - j 154 Ω]

SWR @ load = 13.8:1
w/70ft RG8X → SWR @ source= 5.4:1
Total Loss = 4.3 dB [3.3 from SWR] = 63%
80W input → 30W at dipole *[LMR400 = 50W]*

Results – the Timeline



Results – the Timeline



Note the progression:

T

7el 6M

5el 10M

"2½ el" 20M

1 el 15M

1 el low HF

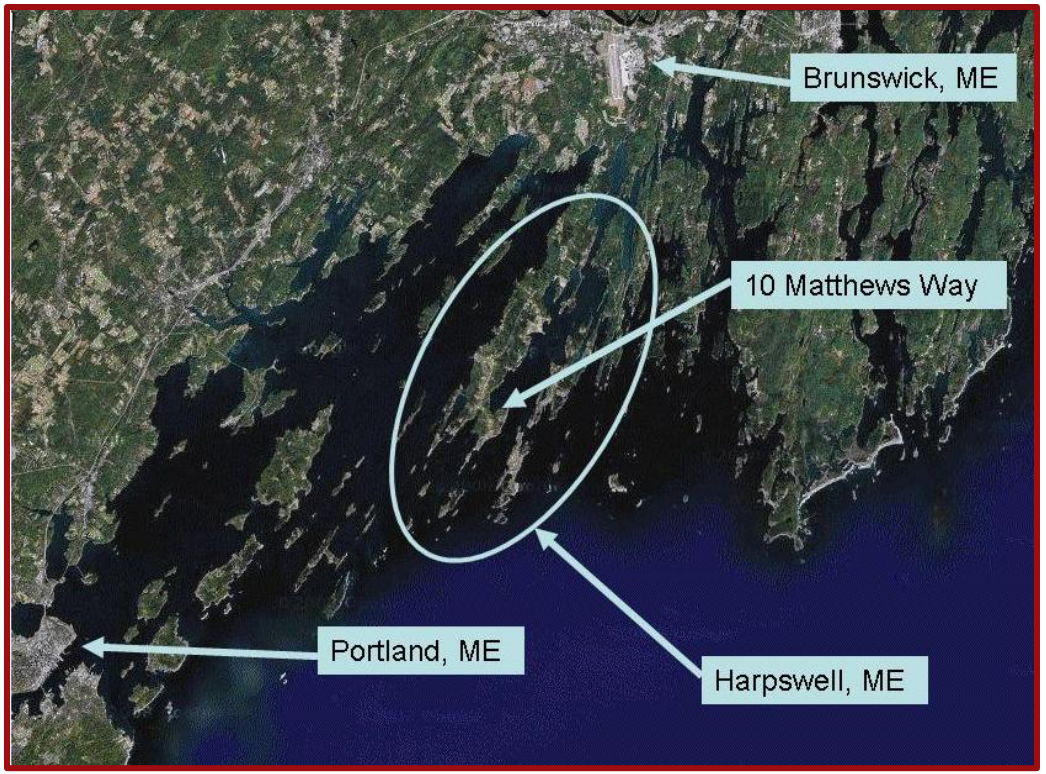
Agenda

- Some History and Philosophy
- Some Antenna *Rules of Thumb*
- Antennas in Woburn
- **Antennas in Harpswell ME**
    - ***Some Lessons Learned***
    - ***Antennas***
- Playing with FT8
- Playing with 160

Harpswell QTH

Summer 2008

A Ham Friendly community

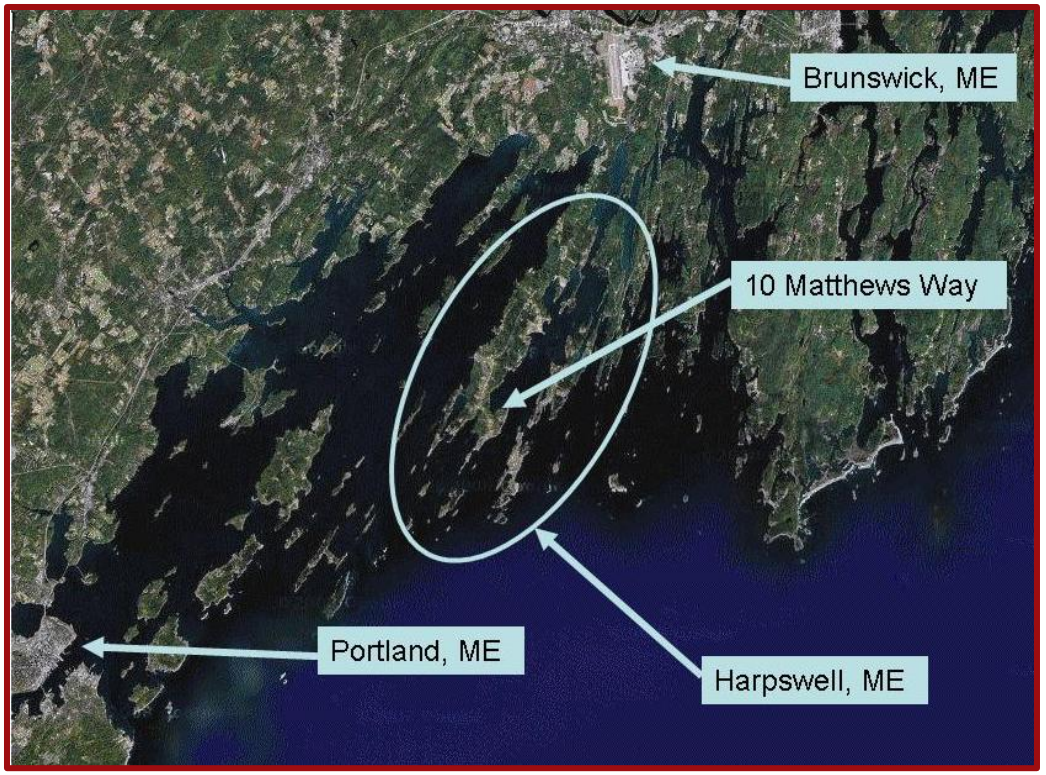


Harpswell QTH

Summer 2008

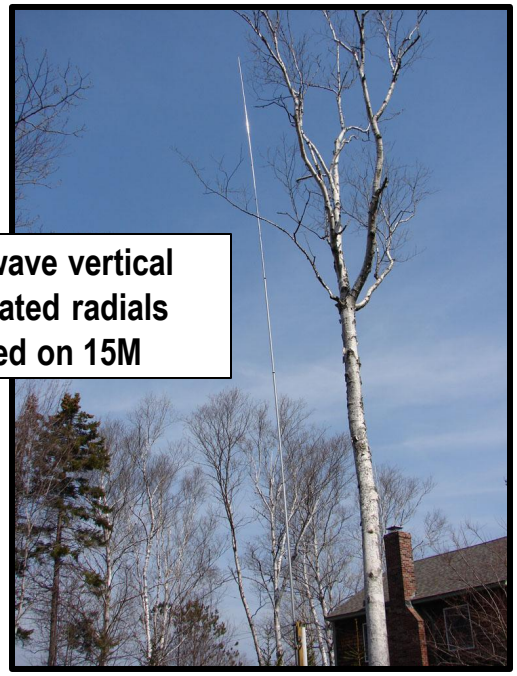
Lessons Learned

- **Simple Antennas "Work" for DX**
  But NOT for contesting…
  - Antenna Modeling
  - Stay off roof
  - Be able to raise by myself
- **Coax: Best you can afford**
  - Model with TLW
- **Good Grounding**
  - New ARRL Book: Grounding and Bonding for the Radio Amateur
- **Get Involved!**
  - MMRA / MARA / FEMARA
  - YCCC / NEWS
  - TowerTalk Reflector
  - Specific Antenna Reflectors
  - Specific Rig Reflectors
  - Specific Logger Reflector



A Ham Friendly community

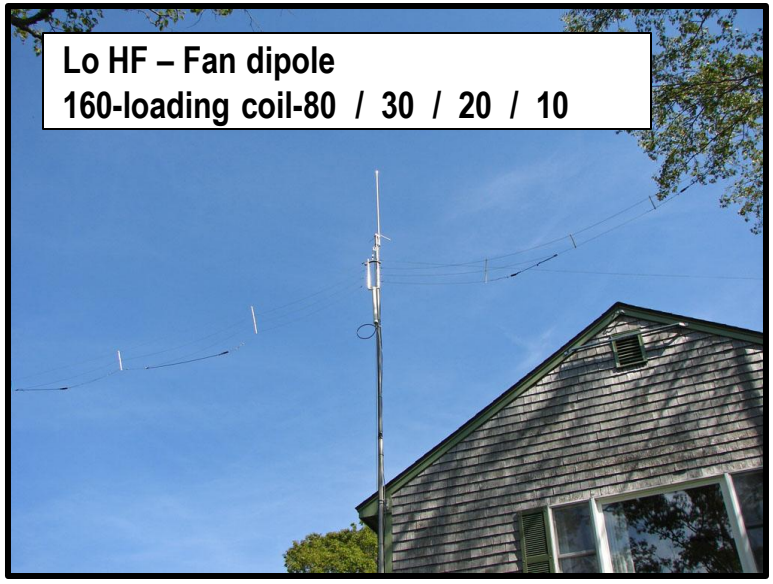
Harpswell ME Station



40M ¼ wave vertical
w/4 elevated radials
Also used on 15M

5 year old TS-590S

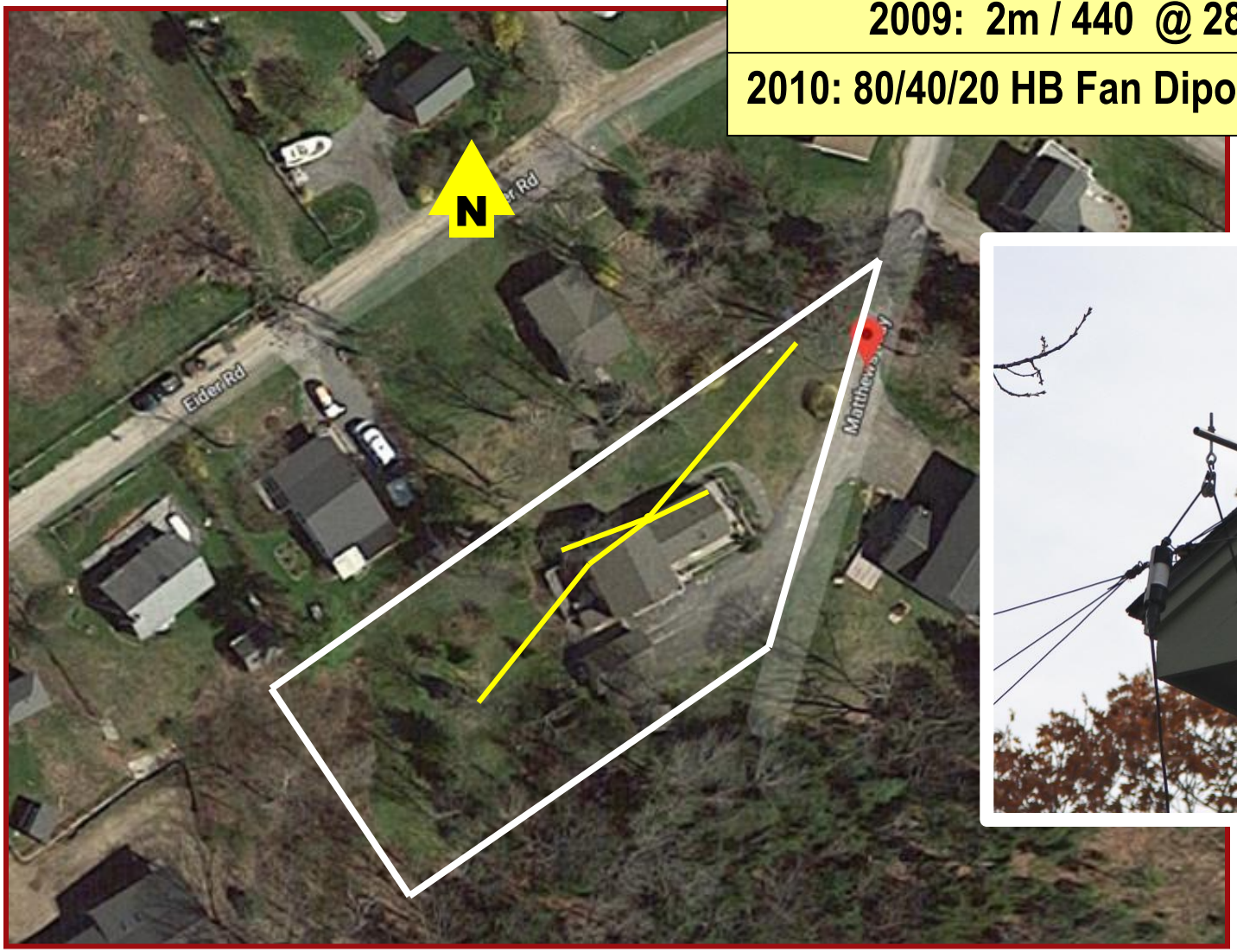
6M
3el InnovAntenna LFA



Lo HF – Fan dipole
160-loading coil-80 / 30 / 20 / 10

Harpswell QTH

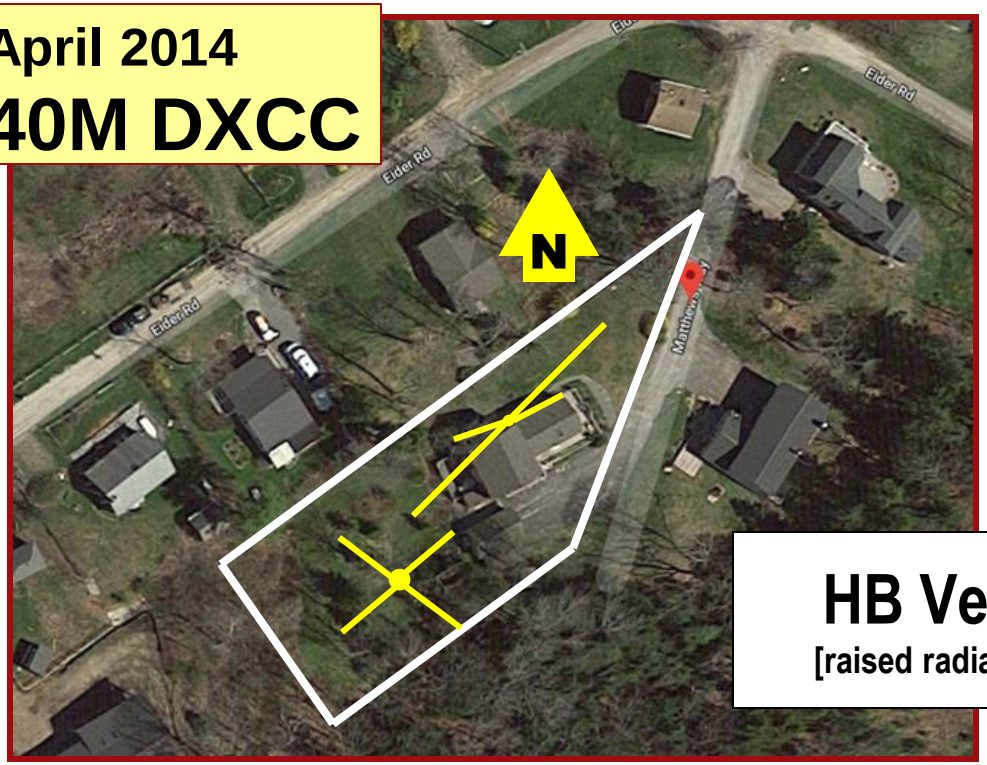
2008: Purchased
2009: 2m / 440 @ 28ft.
2010: 80/40/20 HB Fan Dipole @ 20ft.



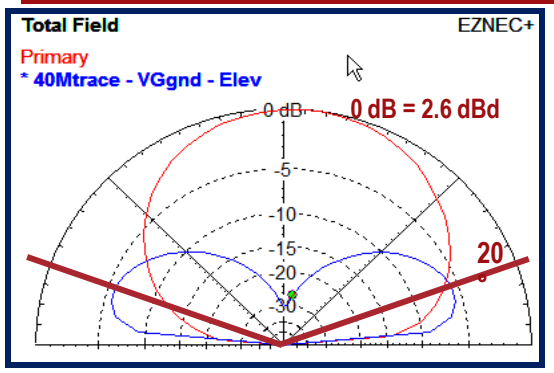
Harpswell QTH

Set Goal → Build Antenna → Results

April 2014
40M DXCC



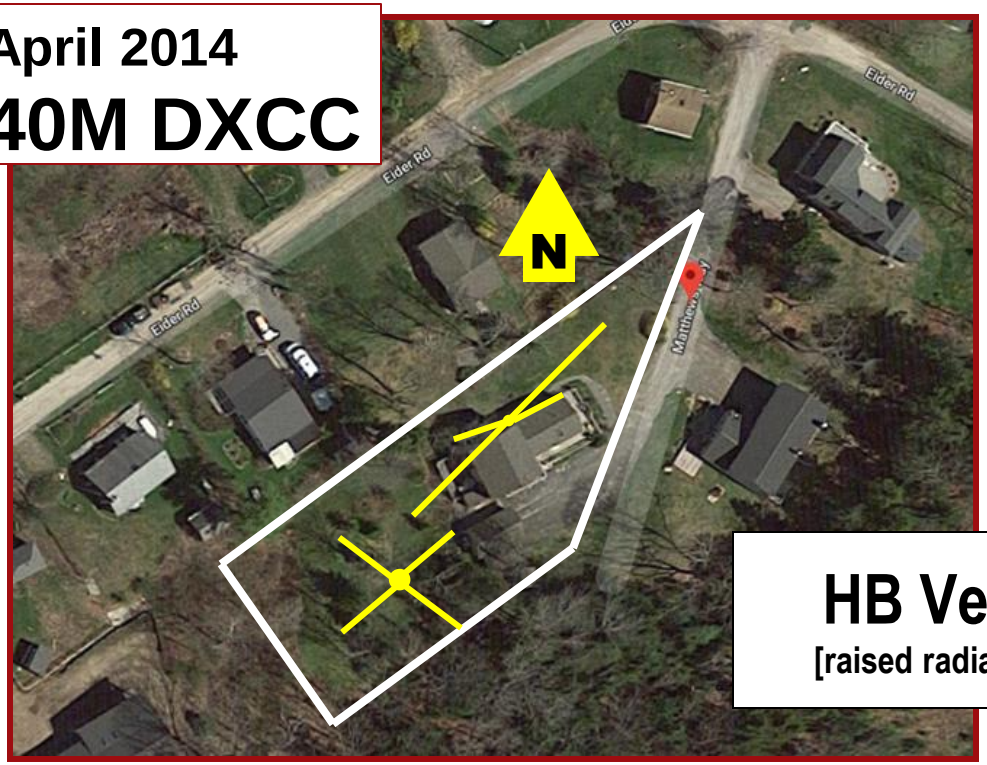
HB Vertical
[raised radials @ 10ft]



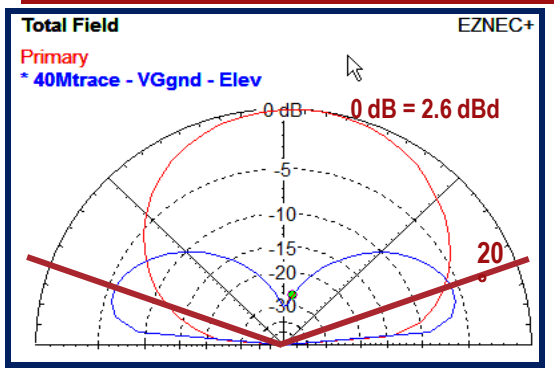
Harpswell QTH

Set Goal → Build Antenna → Results

April 2014
40M DXCC



HB Vertical
[raised radials @ 10ft]

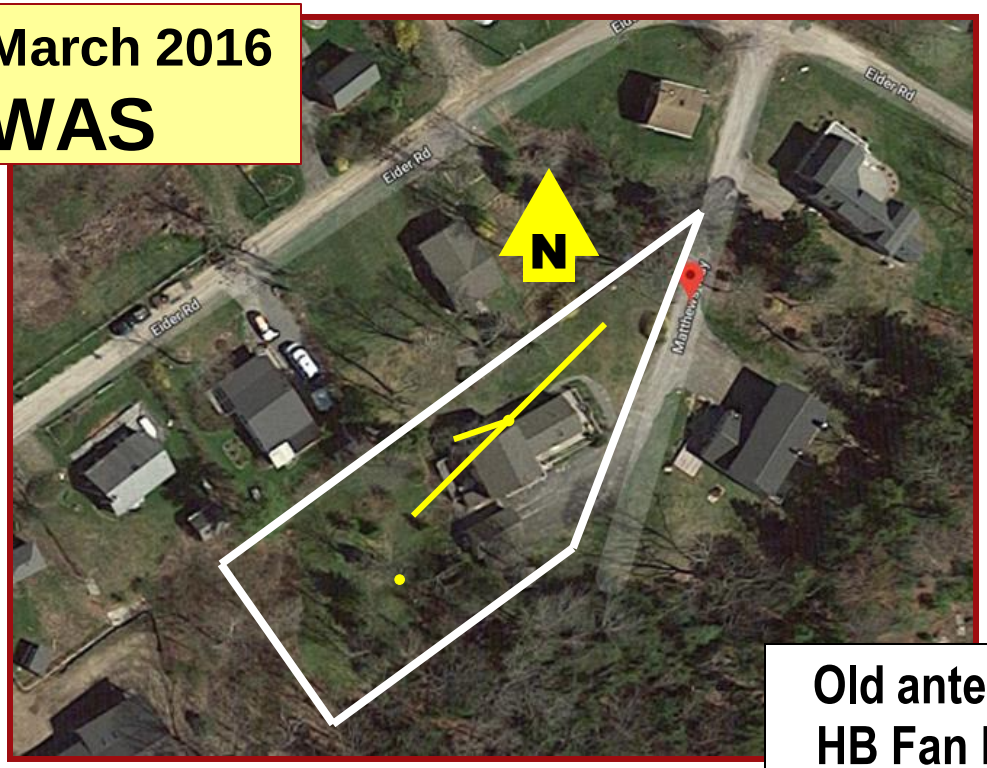


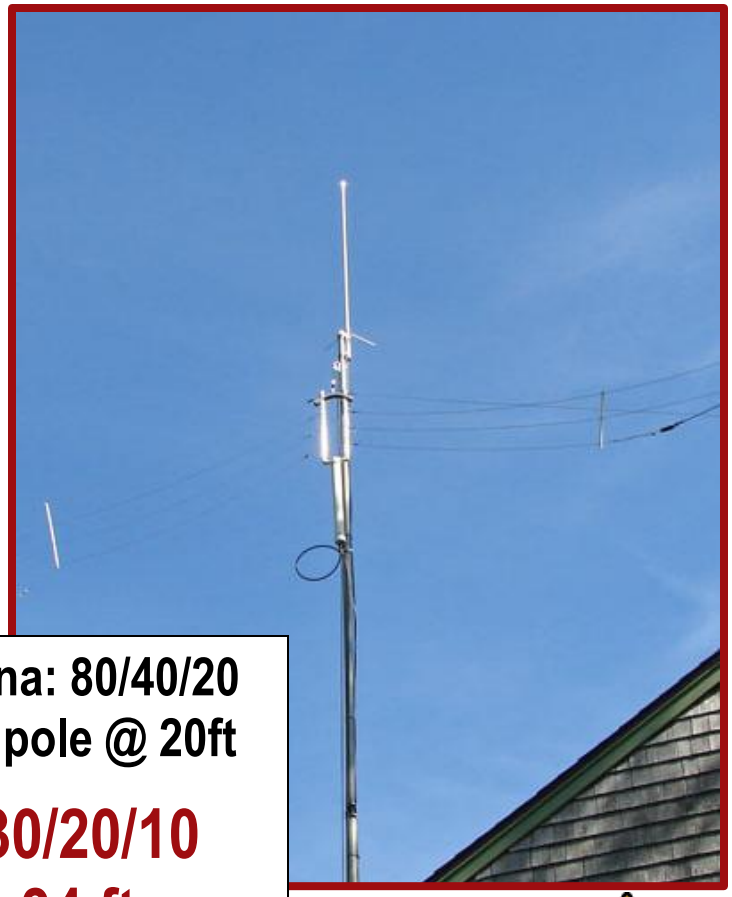
40M DXCC
Sept 2016

Harpswell QTH

Set Goal → Build Antenna → Results

March 2016
WAS





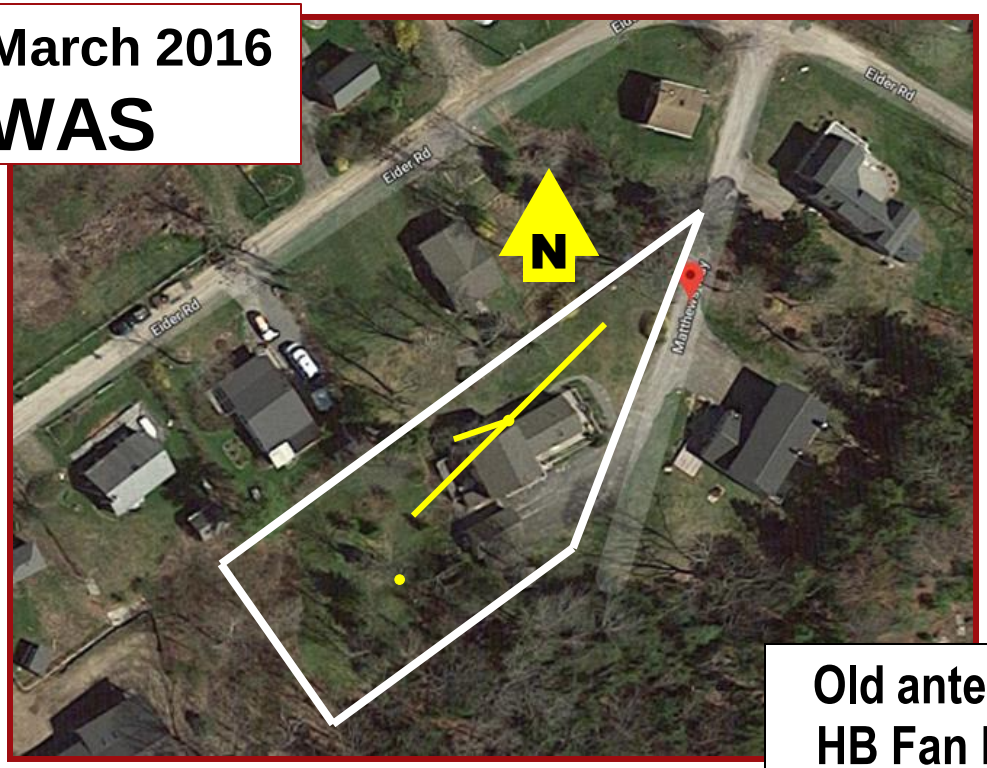
Old antenna: 80/40/20
HB Fan Dipole @ 20ft

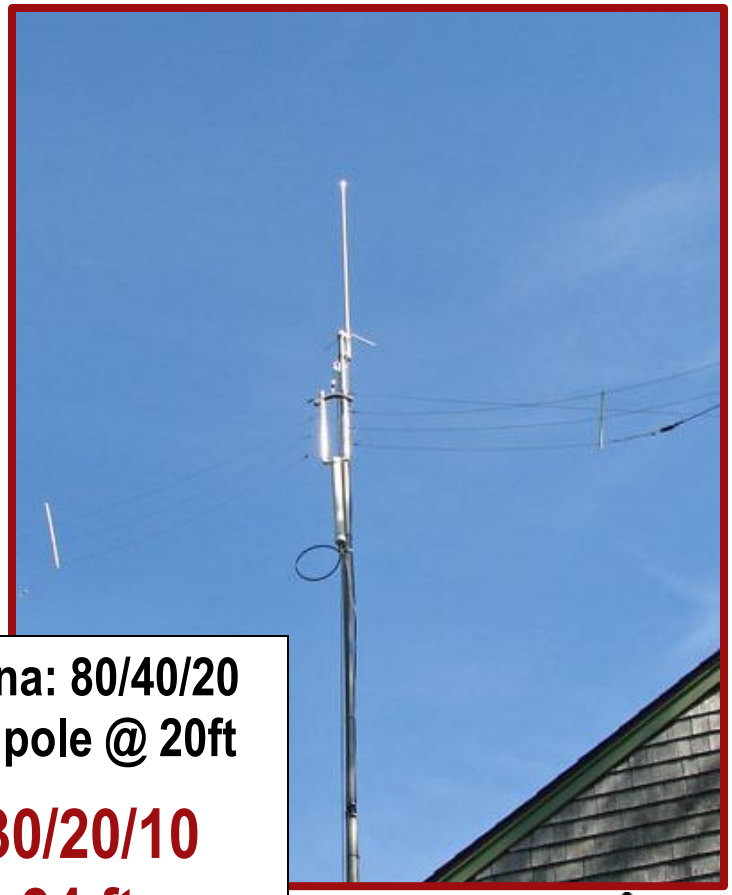
→80/30/20/10
@ 34 ft

Harpswell QTH

Set Goal → Build Antenna → Results

March 2016
WAS



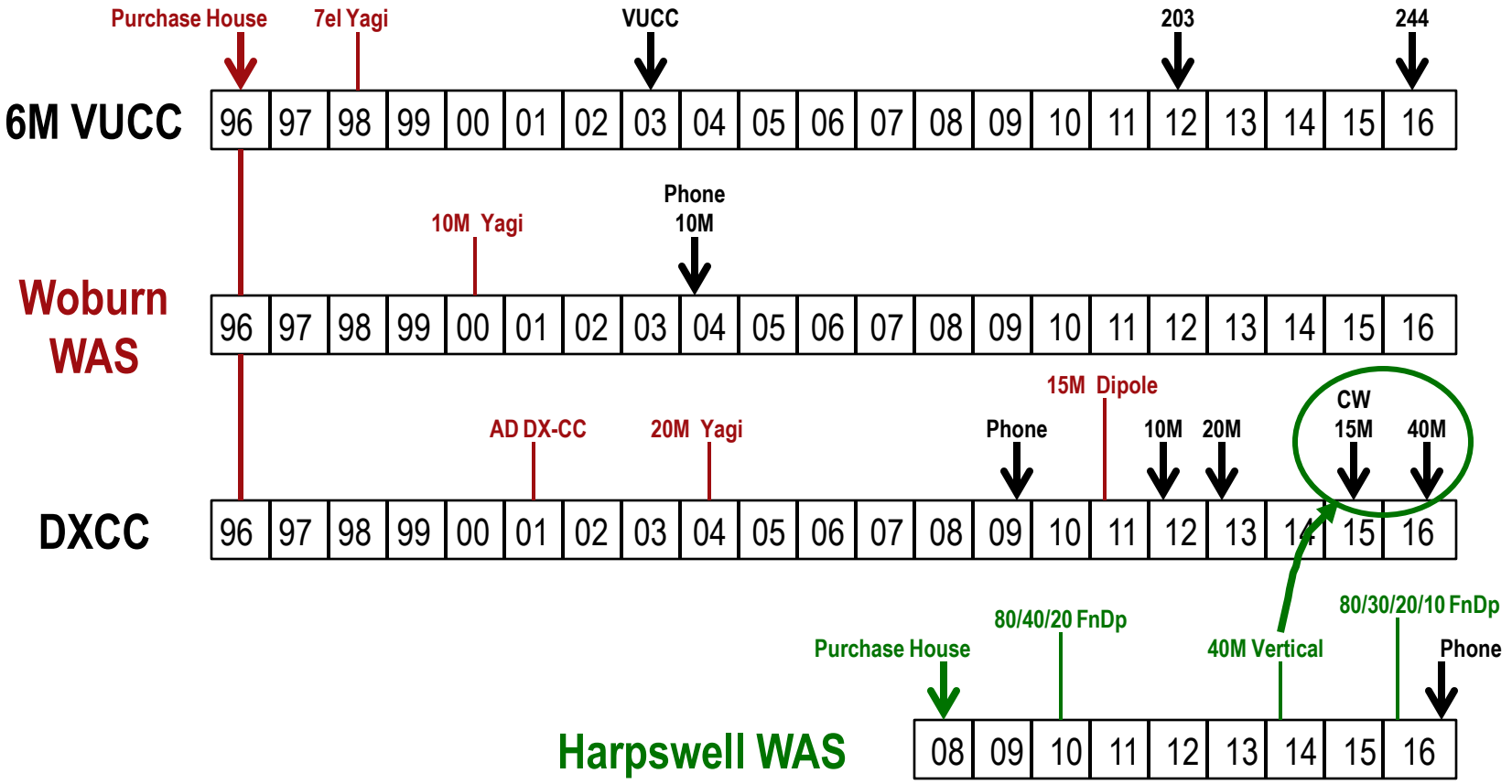


Old antenna: 80/40/20
HB Fan Dipole @ 20ft

→80/30/20/10
@ 34 ft

→WAS
Sept 2016

Results – the Updated Timeline



Agenda

- Some History and Philosophy
- Some Antenna *Rules of Thumb*
- Antennas in Woburn
- Antennas in Harpswell ME
- **Playing with FT8 – *a digression***
  - ***Given up on PSK years ago***
  - ***Tried JT65* – slow!**
  - ***Fast and More Sensitive than CW***
- Playing with 160

Agenda

- Some History and Philosophy
- Some Antenna *Rules of Thumb*
- Antennas in Woburn
- Antennas in Harpswell ME
- **Playing with FT8 – *a digression***
  - ***Given up on PSK years ago***
  - ***Tried JT65* – slow!**
  - ***Fast and More Sensitive than CW***
  - ***Makes simple antennas viable***
- Playing with 160

Typical S/N (BW = 2500 Hz.):

SSB	+10 dB
CW	+/- 0 → - 10 dB
	- 15 (best radio/ears)
FT8	- 21 dB
WSPR	- 31 dB

What is FT8? p/o WSJT-X: *W*eak *S*ignal communications by K1*JT*

Steven Franke: K9AN Joe Taylor: K1JT

8-frequency shift keying format Tone spacing: 6.25 Hz 50 Hz bandwidth

WSJT-X includes modes: FT8, JT4, JT9, JT65, QRA64, ISCAT, MSK144, WSPR, Echo

- *Designed for WEAK SIGNAL Qs*
- *Absolute minimum QSO info*
- *Maximum of 13 free form characters*
- *Very structured syntax*

ME	THEM
CQ W1DYJ FN42	
	W1DYJ W1XXX FN43
W1XXX W1DYJ -MM	
	W1DYJ W1XXX R-NN
W1XXX W1DYJ RRR	
	W1DYJ W1XXX 73

FT8 is Controversial! *(Disruptive Technology)*

FT8 →→ RTTY

is like

CW →→ Spark

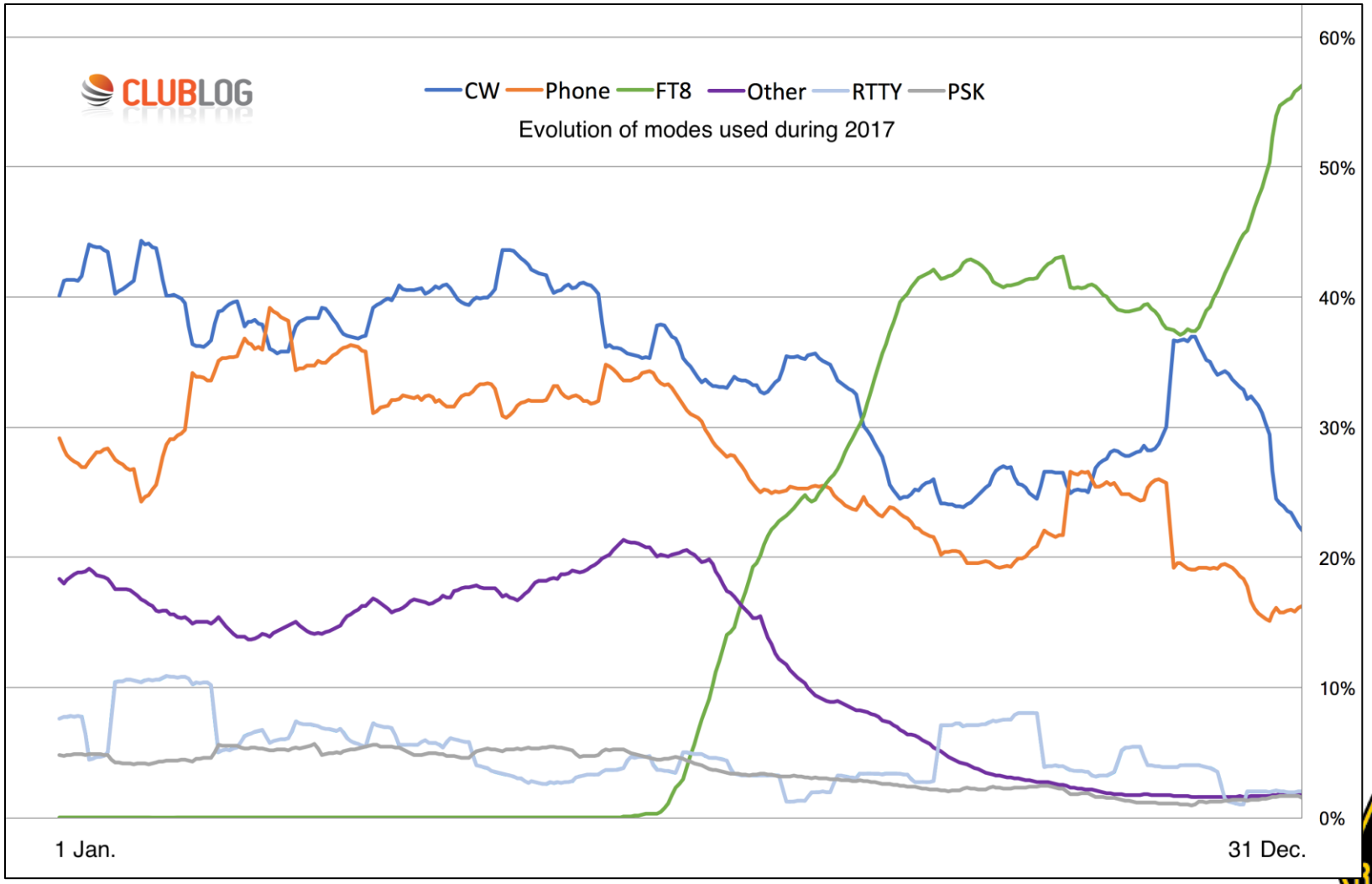
or

SSB →→ AM

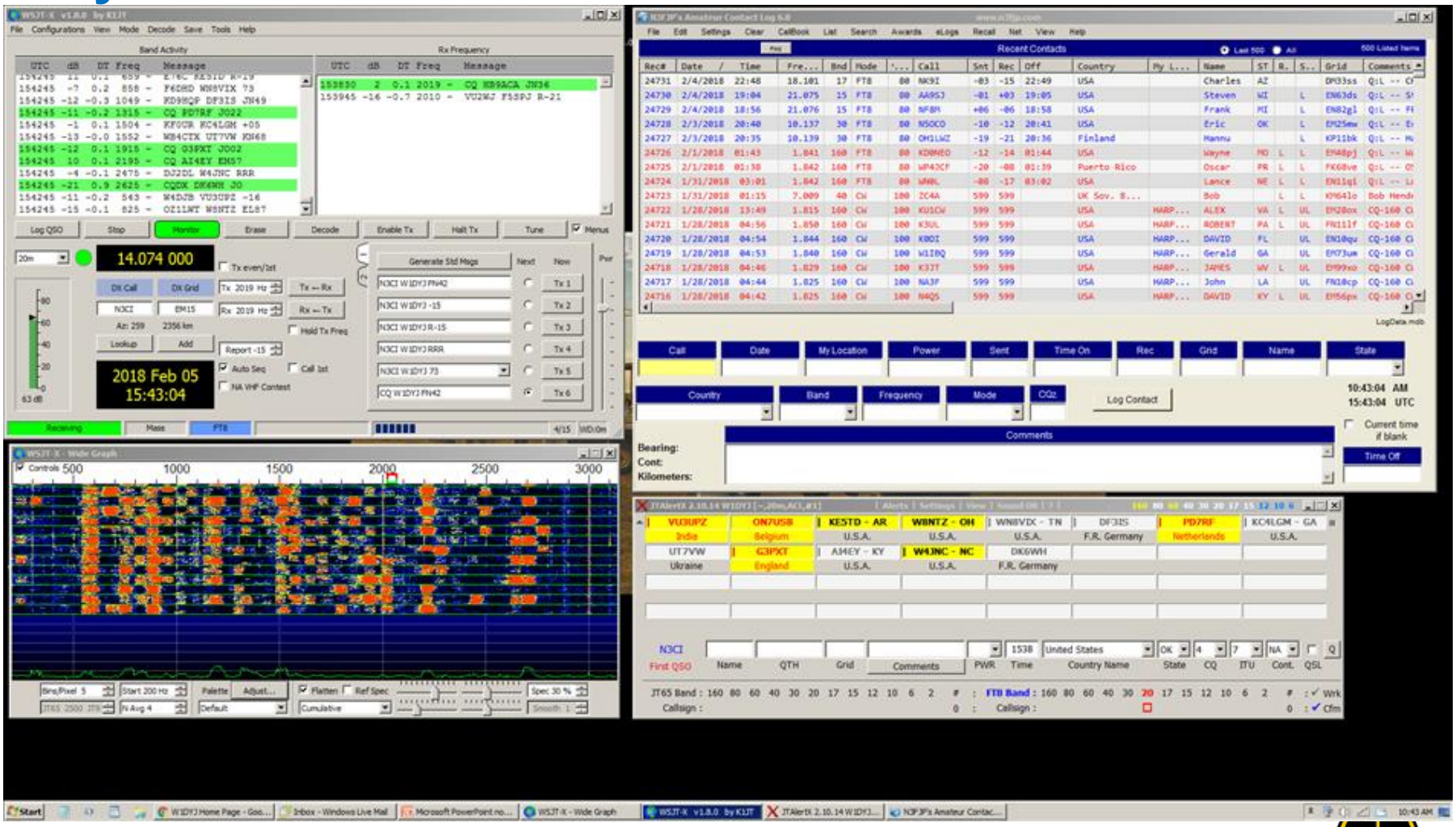
In fact, in VHF contests it is "replacing" BOTH CW and SSB

New "versions" for DX / FD / etc. released or will be.

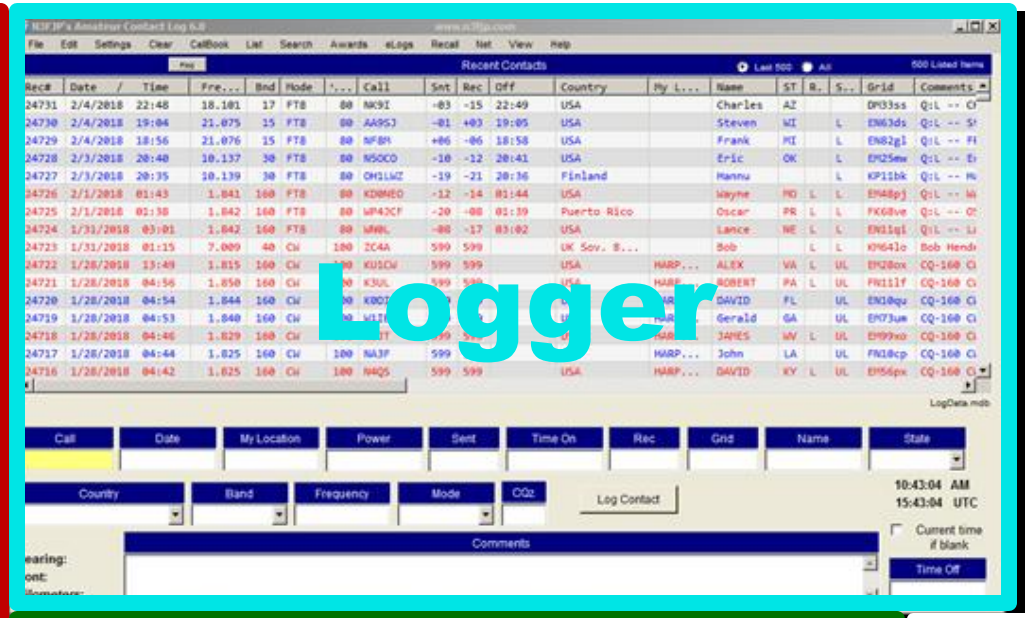
FT8 in 2017

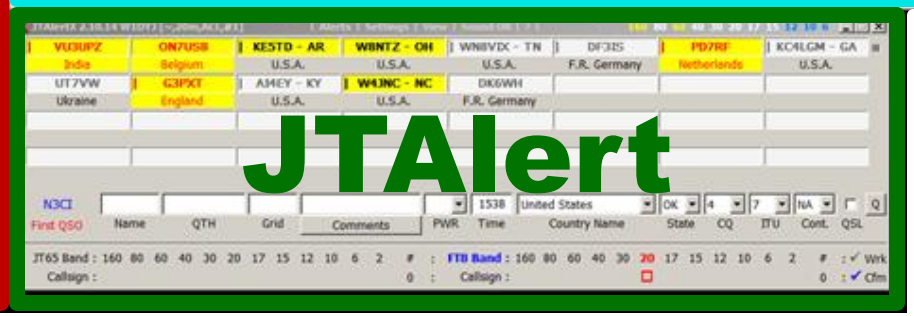

CLUBLOG
CW Phone FT8 Other RTTY PSK
Evolution of modes used during 2017
60%
50%
40%
30%
20%
10%
0%
1 Jan.
31 Dec.

My 23" Monitor

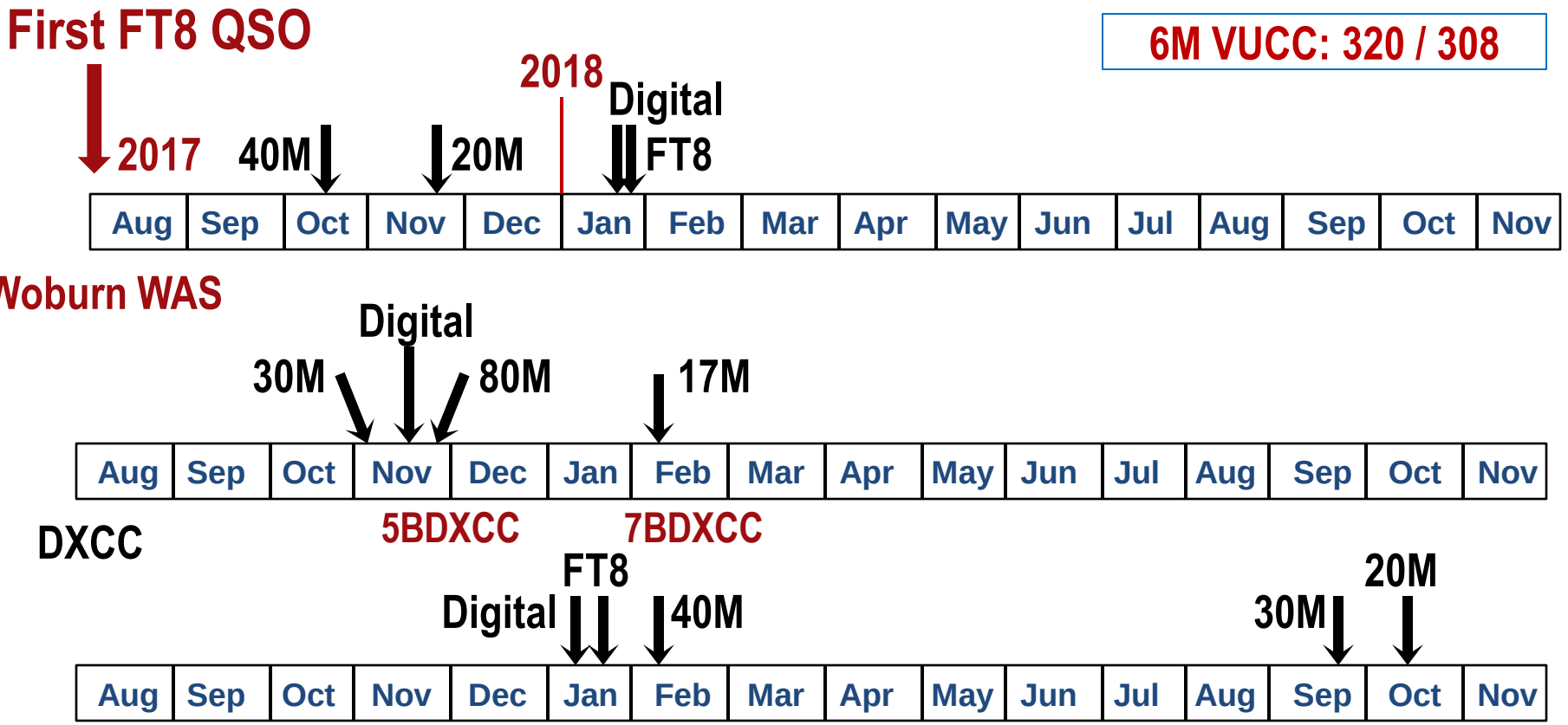


My 23" Monitor



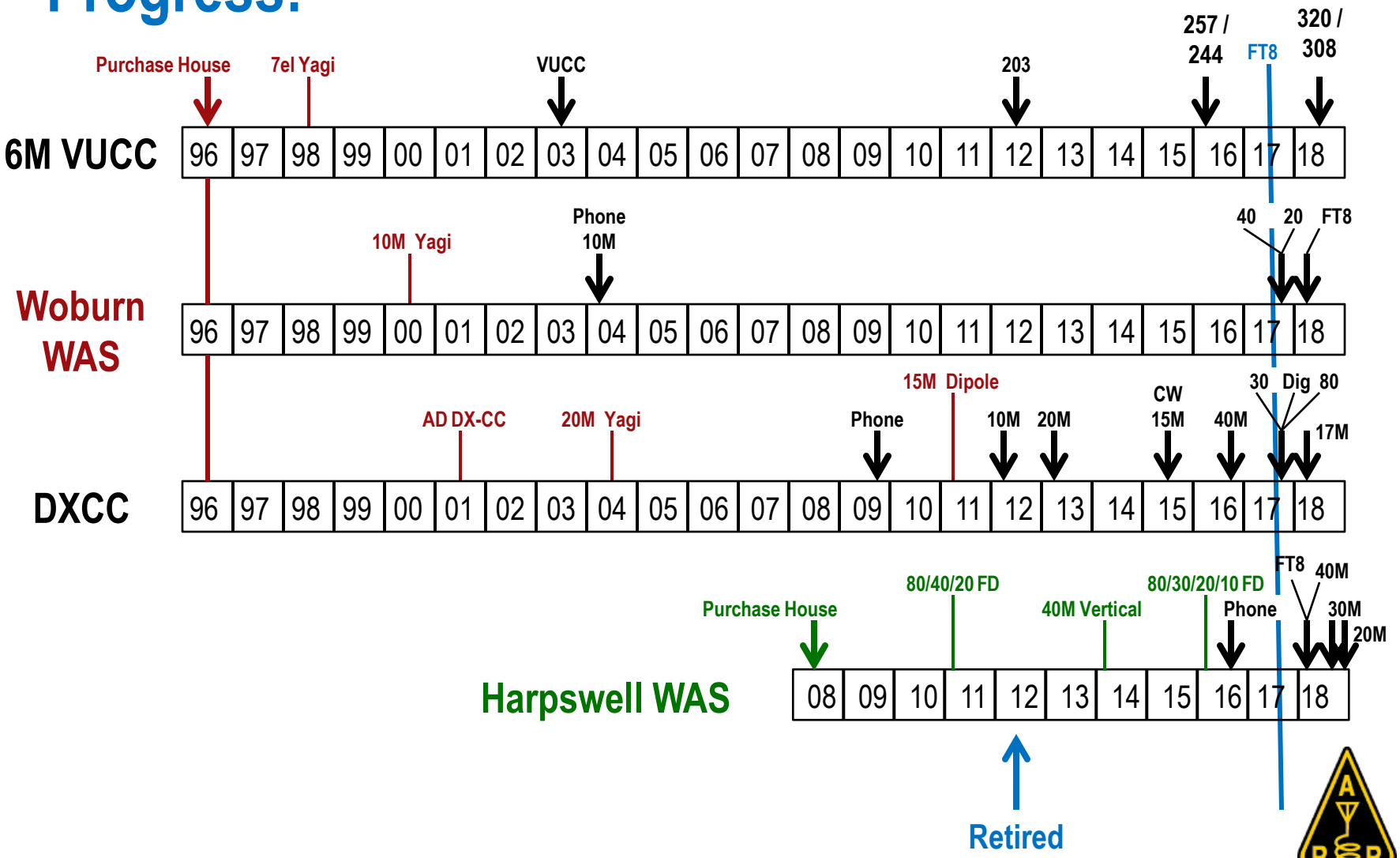


FT8 — Results



Most FT8 hams are on LoTW!

Progress!


Purchase House
7el Yagi
VUCC
203
257 / 244
FT8
320 / 308
6M VUCC
96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18
10M Yagi
Phone 10M
40
20
FT8
Woburn WAS
96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18
AD DX-CC
20M Yagi
15M Dipole
Phone
10M
20M
CW 15M
40M
30
Dig
80
17M
DXCC
96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18
Purchase House
80/40/20 FD
40M Vertical
80/30/20/10 FD
Phone
FT8
40M
30M
20M
Harpswell WAS
08 09 10 11 12 13 14 15 16 17 18
Retired

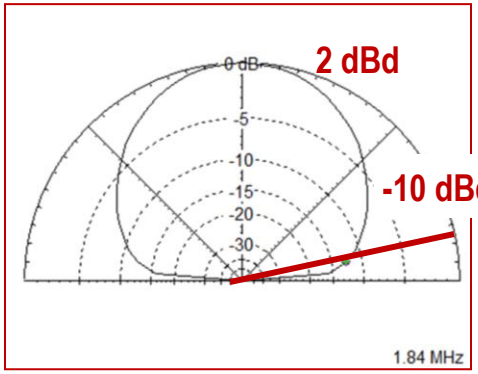
Agenda

- Some History and Philosophy
- Some Antenna *Rules of Thumb*
- Antennas in Woburn
- Antennas in Harpswell ME
- Playing with FT8
- **Playing with 160**
  - ***Already had 7BDXCC***
  - ***Only 160 & 12 left***
  - ***No Sunspots ➔160!***

160 – 1st Attempt: Woburn – Dec 2014

Use 80/40 dipole ARRL 160 CW

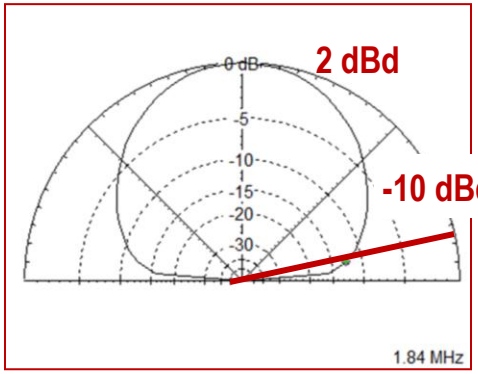
- 80M shortened (loaded) dipole at 20‘ **[.04 λ]**
- Z = 3 – j1000 Ω (EZNEC)
- Calculated SWR at antenna: 485:1 (TLW)
- Fed with ~100' of RG58
- (TLW) Total Loss at least **20dB**
  → Effective Power at antenna ~ **1 watt**



160 – 1st Attempt: Woburn – Dec 2014

Use 80/40 dipole ARRL 160 CW

- 80M shortened (loaded) dipole at 20‘ **[.04 λ]**
- Z = 3 – j1000 Ω (EZNEC)
- Calculated SWR at antenna: 485:1 (TLW)
- Fed with ~100' of RG58
- (TLW) Total Loss at least **20dB**
  → Effective Power at antenna ~ **1 watt**



SOULP

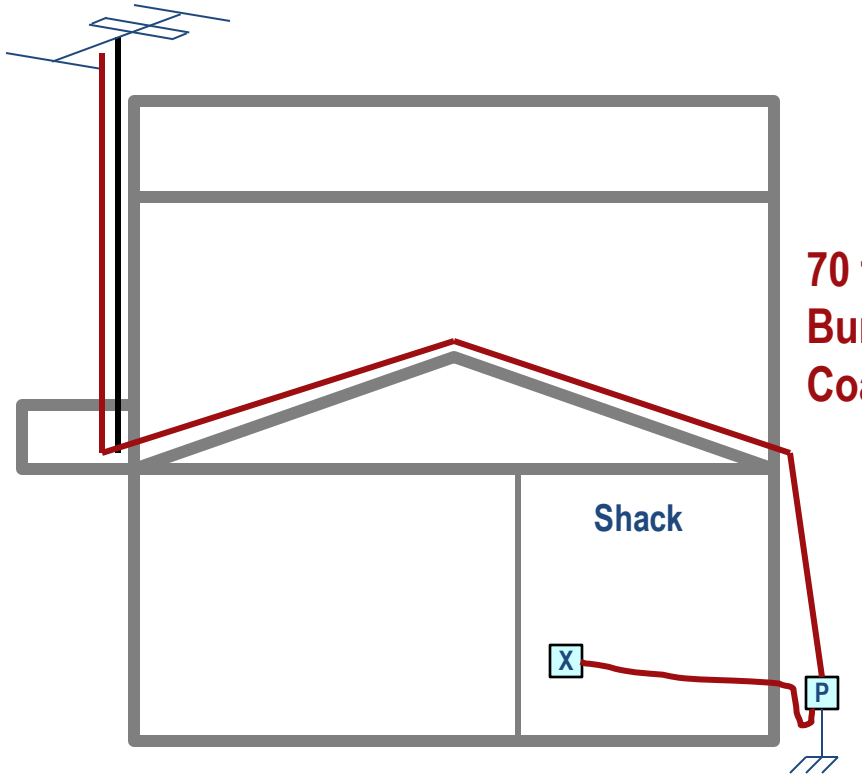
EMA best: 58,946 | 0 DX / 26 Sections

Me: 4% 2132 | 16 States / 2 Provinces

Not very good, but infinitely better than nothing!

160 – 2nd Attempt: Harpswell – Dec 2015

Load up 6M Yagi ARRL 160 CW

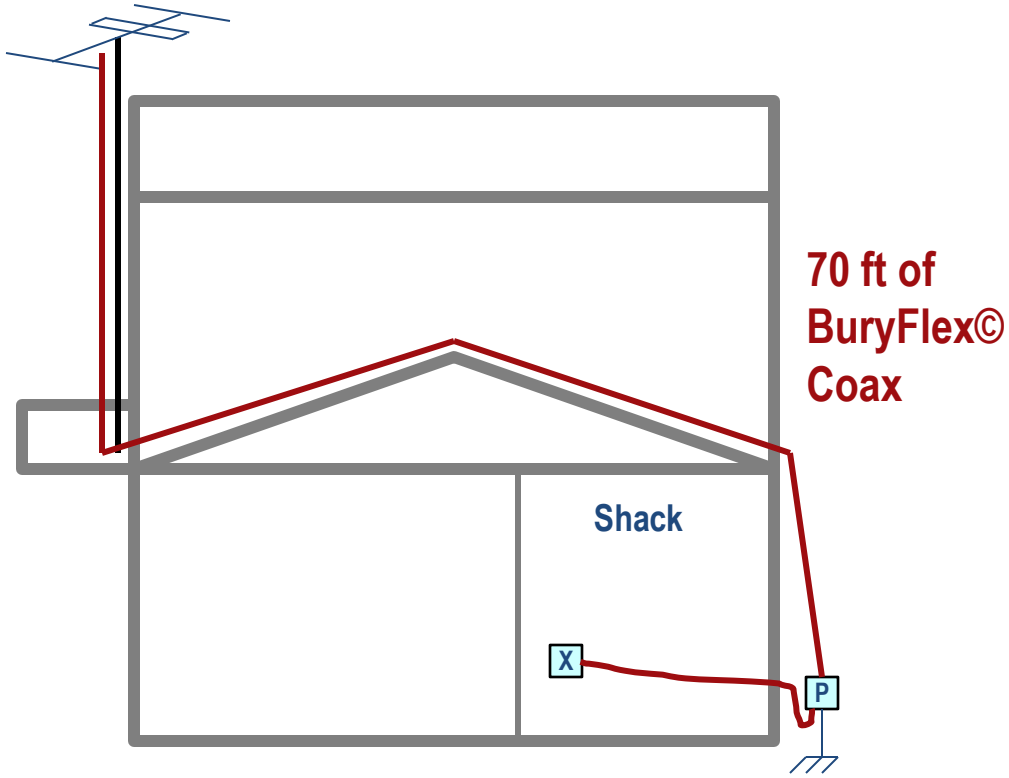


Theory: shield acting like a top-loaded vertical.

1830 KHz = 2.5:1 SWR

160 – 2nd Attempt: Harpswell – Dec 2015

Load up 6M Yagi ARRL 160 CW



Theory: shield acting like a top-loaded vertical.

SOULP

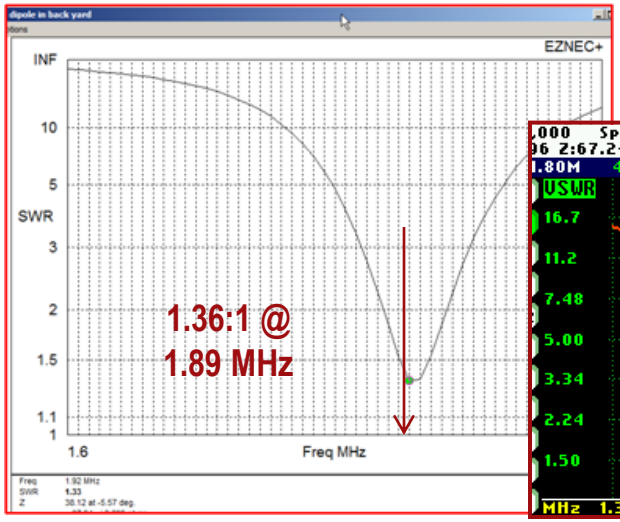
ME best: 110,208 | 1 DX / 33 Sections

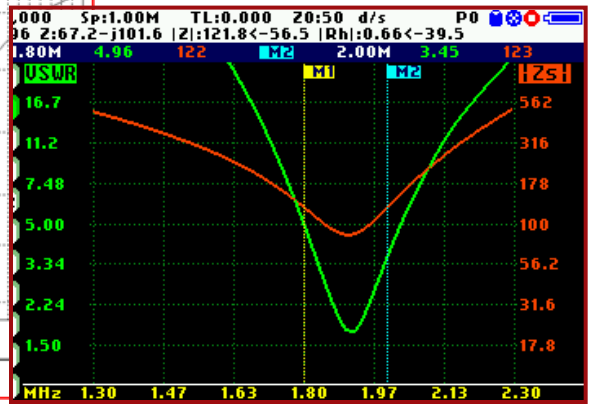
Me: 5% 5379 | Bermuda / 21 States / 2 Provinces

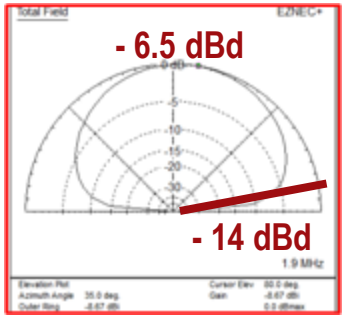
Not very good, but infinitely better than nothing!

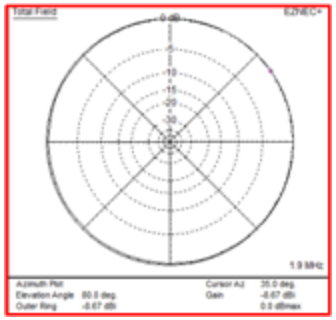
160 – 3rd Attempt: Woburn – Dec 2016

Temporary Dipole ARRL 160 CW



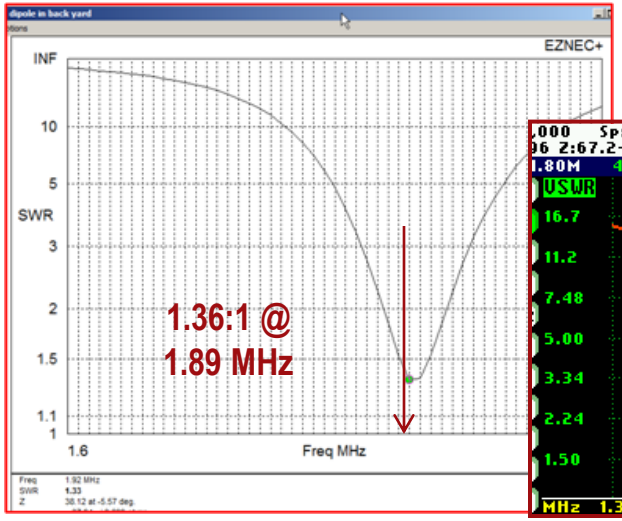


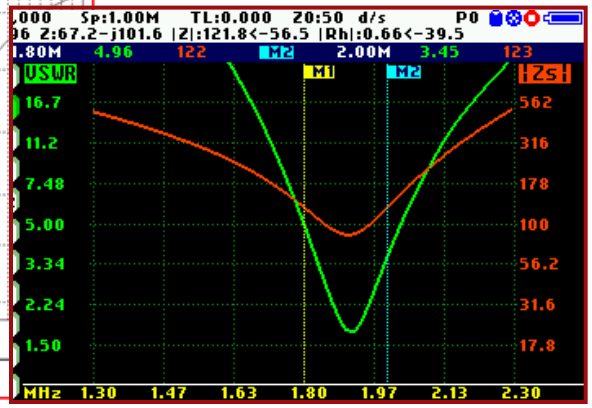


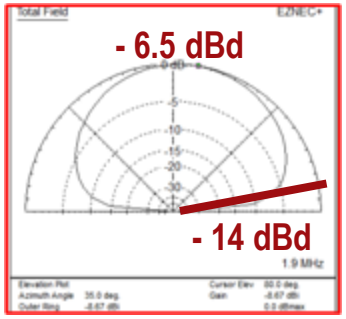


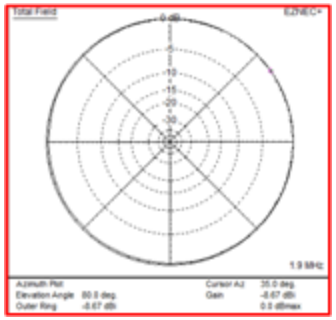
160 – 3rd Attempt: Woburn – Dec 2016

Temporary Dipole ARRL 160 CW









SOULP

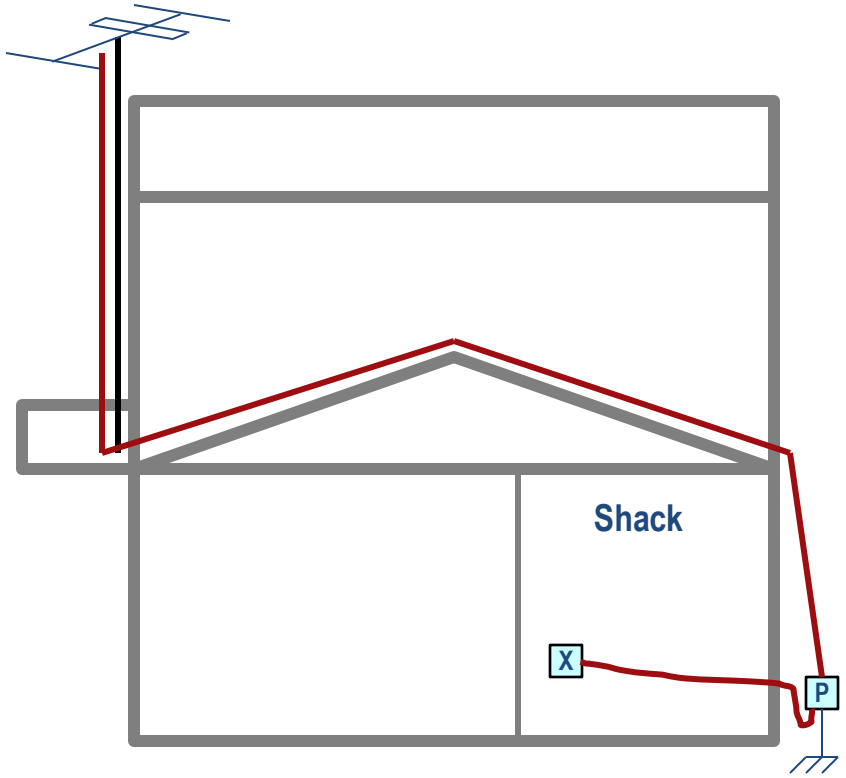
EMA Best: 118,736 | 1 DX / 30 Sections

Me: 5% 6356 | Turks & Caicos/ 21 States / 2 Provinces

Not are very good, but infinitely better than nothing!

160 – 4th Attempt: Harpswell – Jan 2017

Load up 6M Yagi CQ 160 CW



SOULP

ME Best: 118,179 | 3 DX / 25 States, Provinces

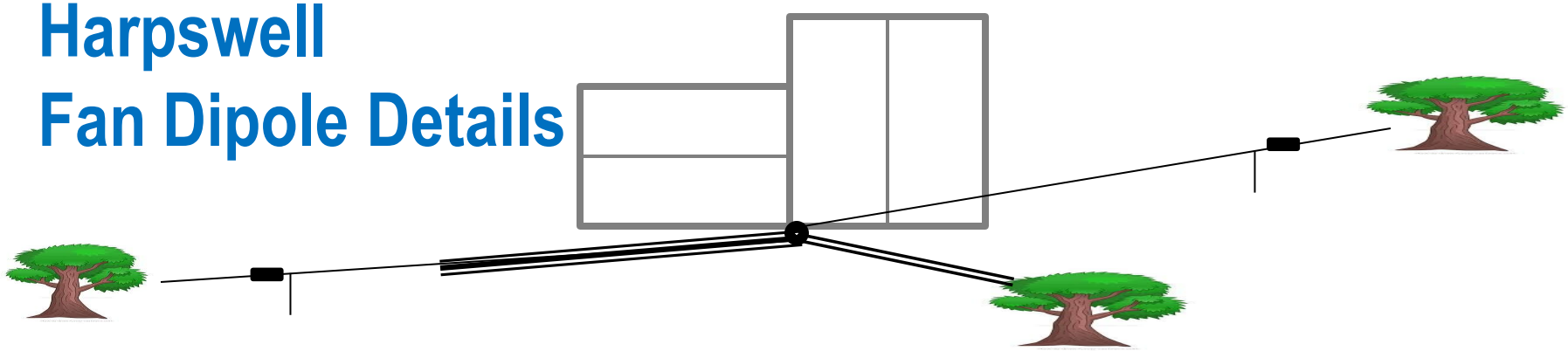
Me: 5% 4,806 | Bahamas / England / Morocco / 21 States / 2 Provinces

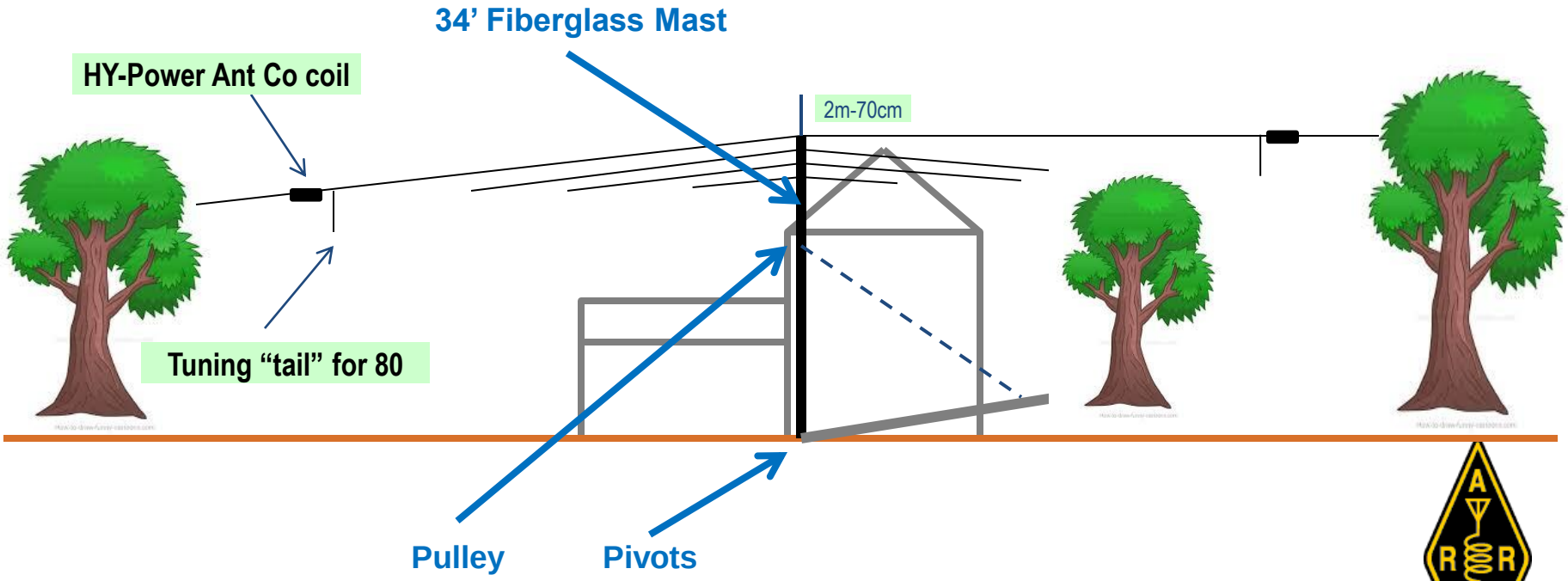
Not very good, but infinitely better than nothing!

160 – More Attempts

Harpswell: Added 160 to Fan Dipole

Harpswell Fan Dipole Details





160 – More Attempts

Harpswell: Added 160 to Fan Dipole

December 2017 — ARRL 160 CW

10 DX / 50 Sections

Aland Is / Bahamas / Bulgaria / Cayman Is / France
Madeira Is / Scotland / Ukraine / US Virgin Is / Wales

Best: 64021 Me: 21603 34%

January 2018 — CQ 160 CW

24 DX / 41 States, Provinces

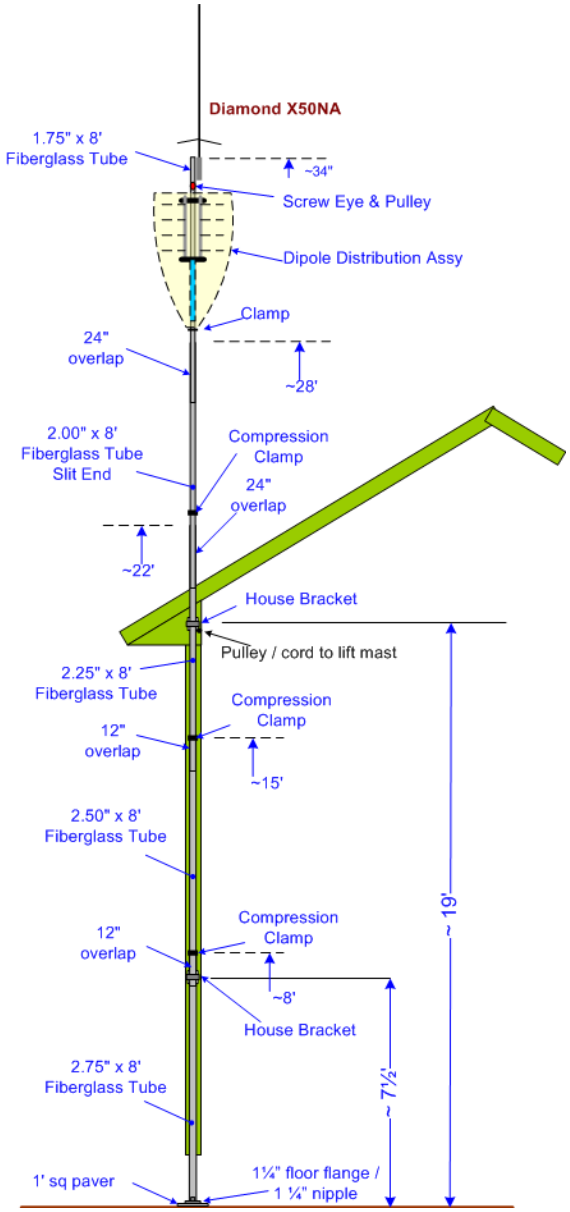
Best: 36704 Me: 36704 100%

→ low power, assisted

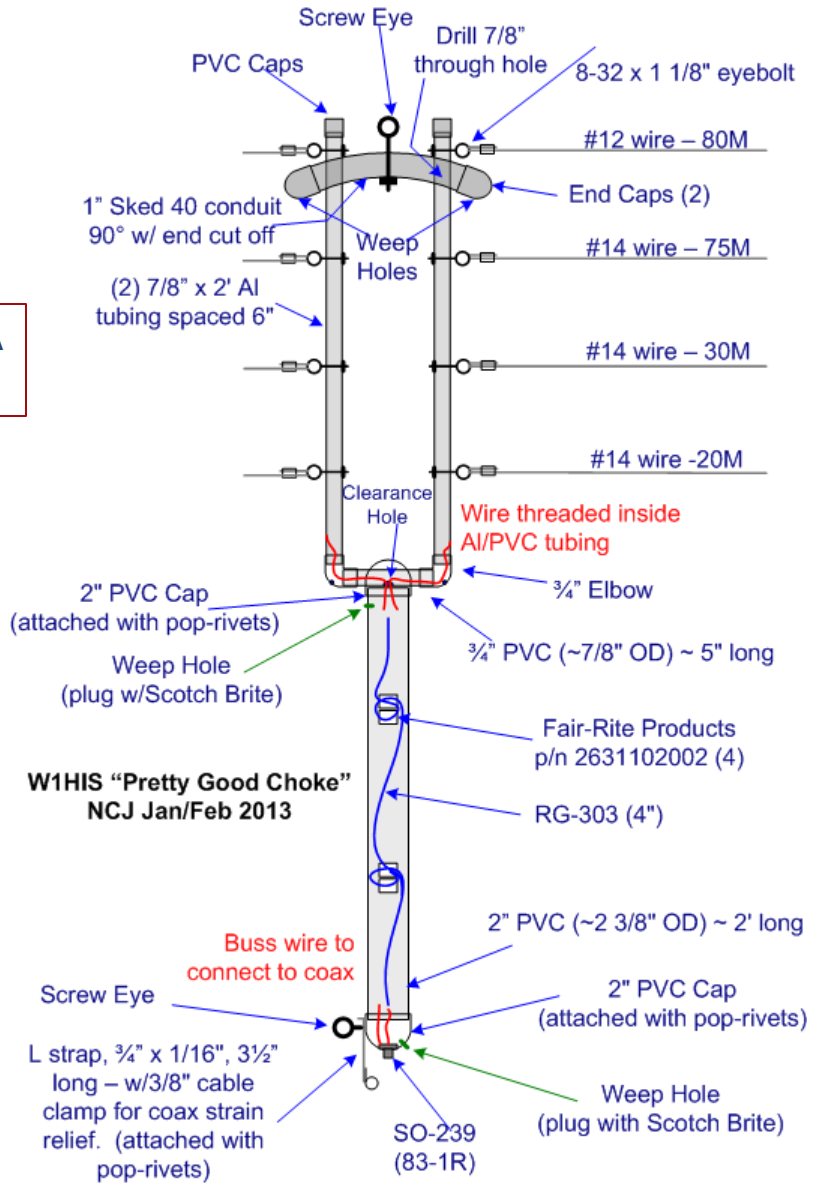
Note: High Power "BEST" was 173,445 or 21%

Currently: 40 States (5 Ph / 37 CW / 21 Dig) 50 DX (3 Ph / 31 CW / 26 Dig)

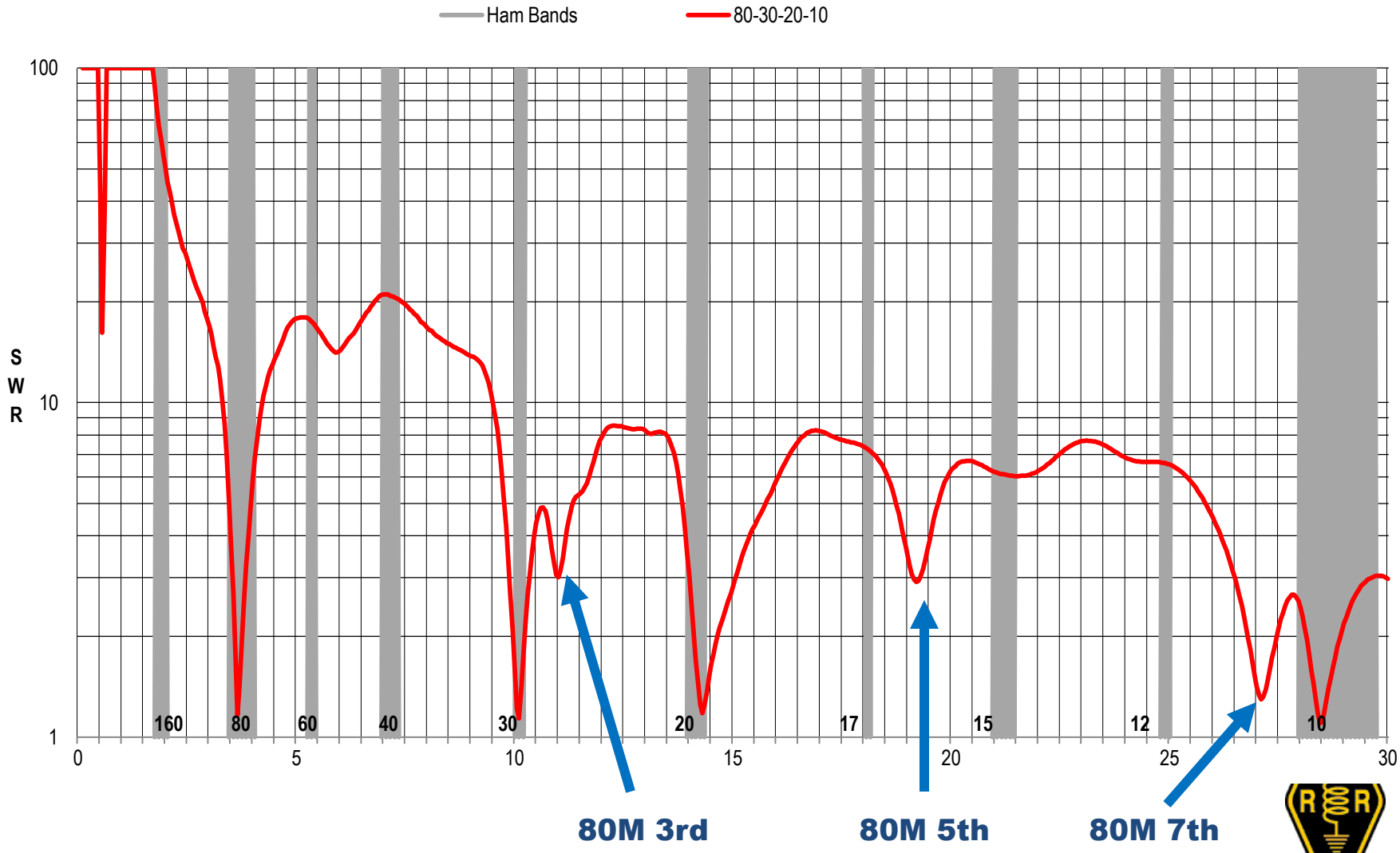
Fan Dipole Details



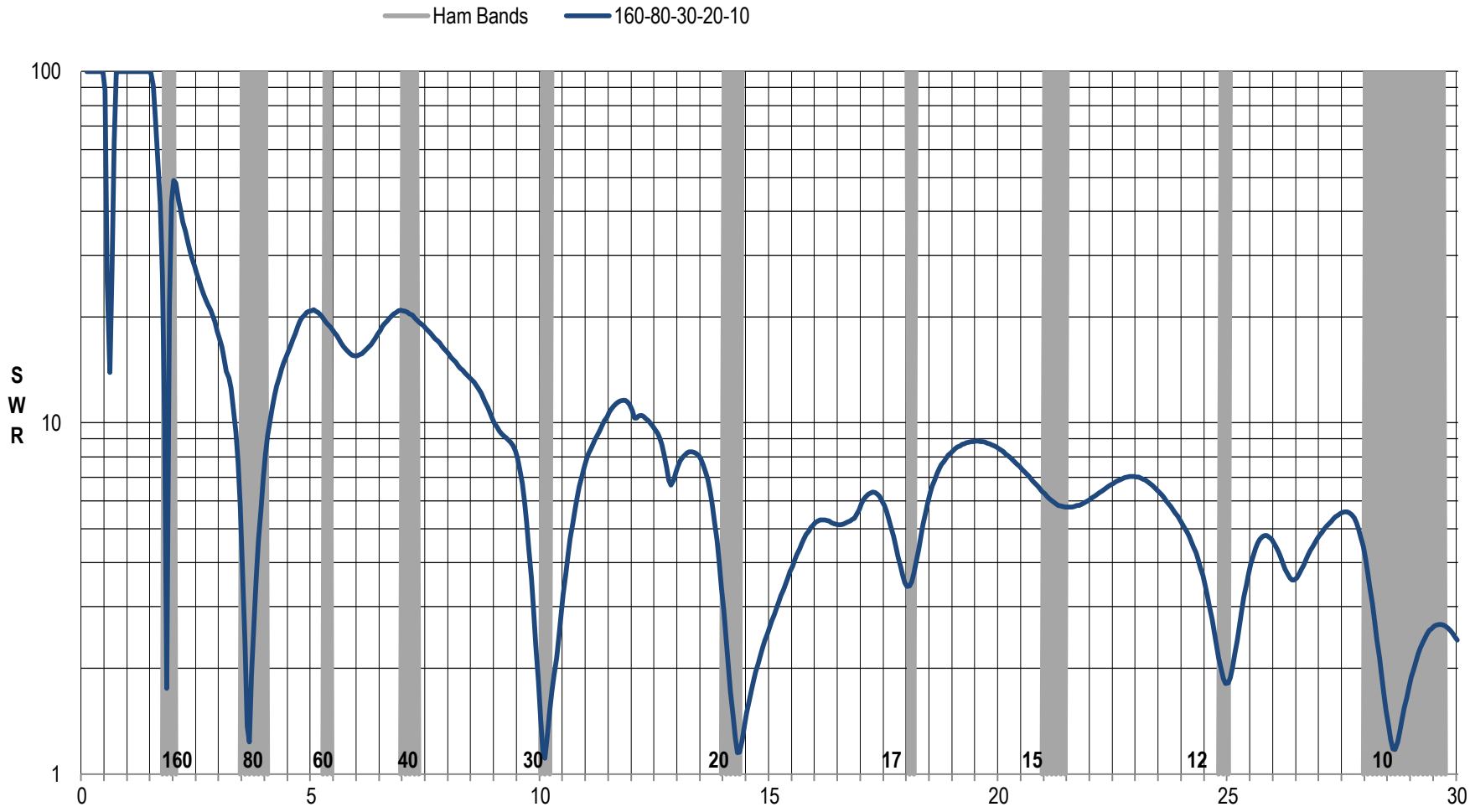
Fan Dipole Details



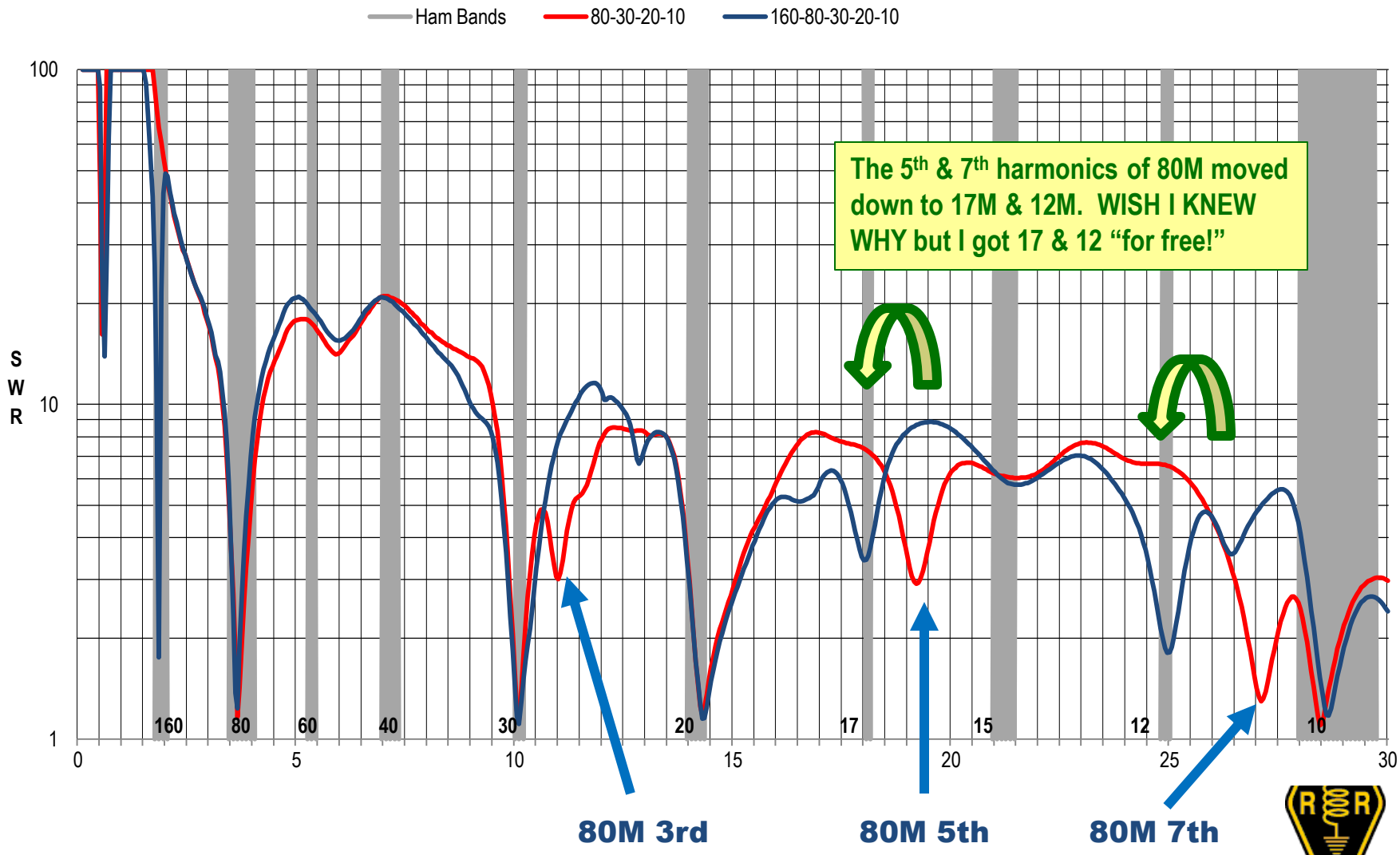
Fan Dipole Details — 80 / 30 / 20 / 10 Sweep [SARK110]



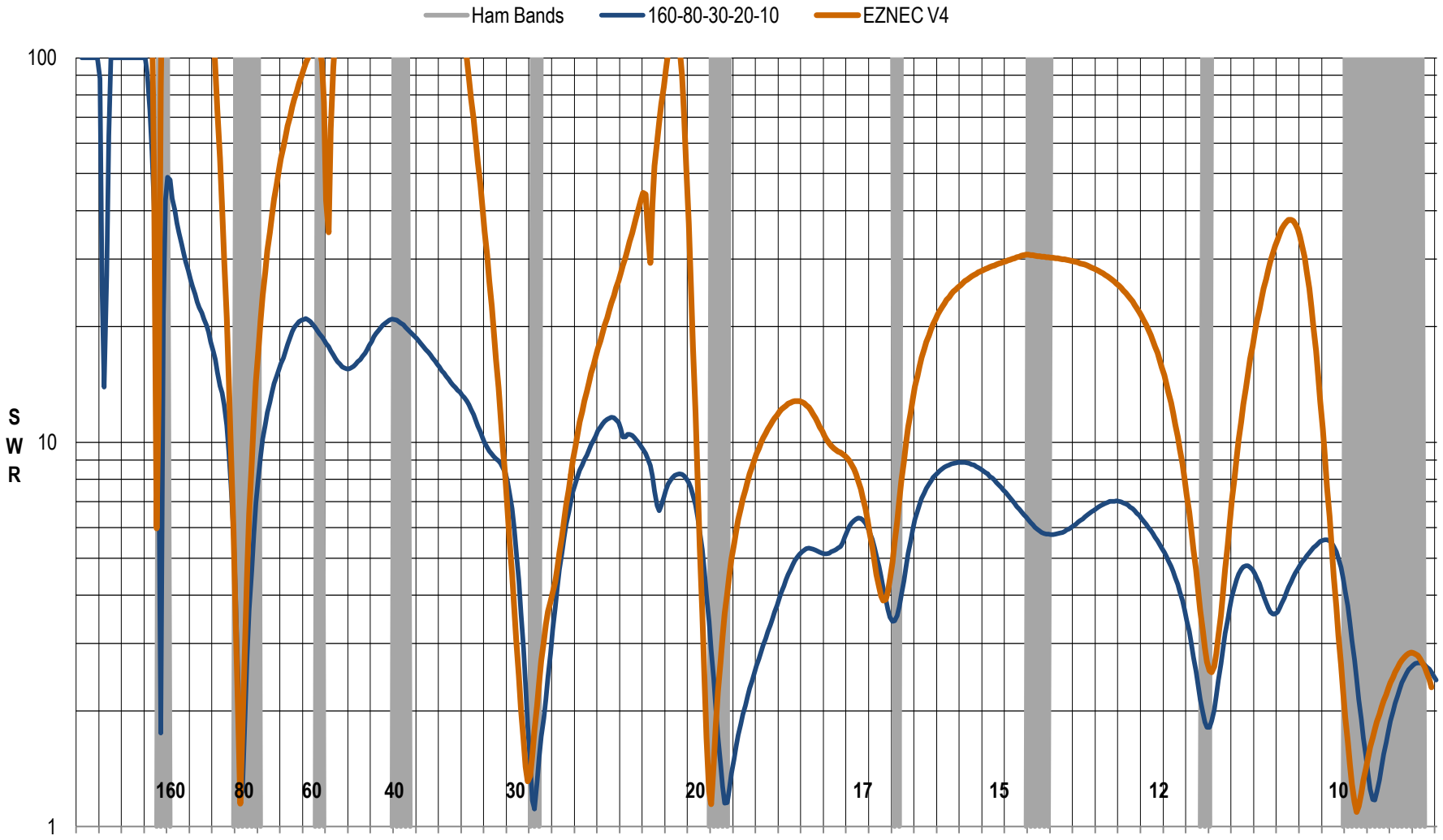
Fan Dipole Details — 160 / 80 / 30 / 20 / 10 Sweep [SARK110]



Fan Dipole Details — Sweep Comparison

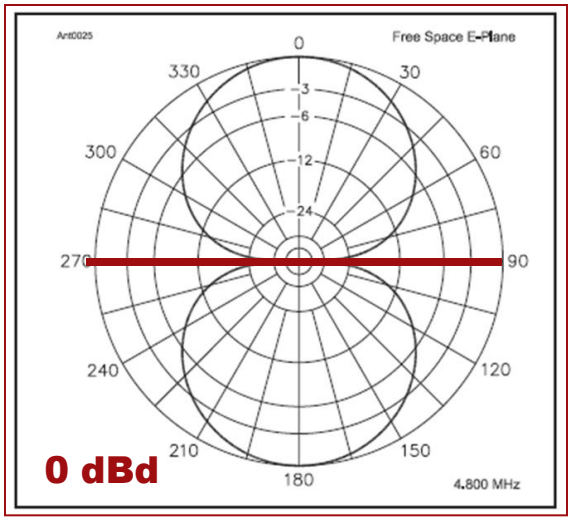


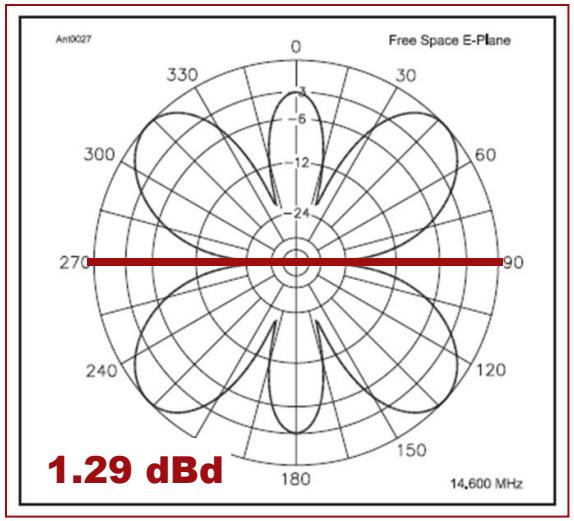
Fan Dipole Details — SARK 110 Sweep vs. EZNEC Model

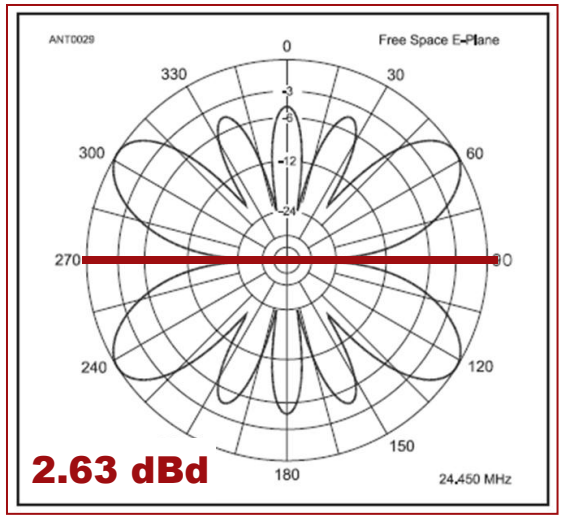


One more bit of antenna theory

Dipole patterns at harmonics







$L = \lambda/2$

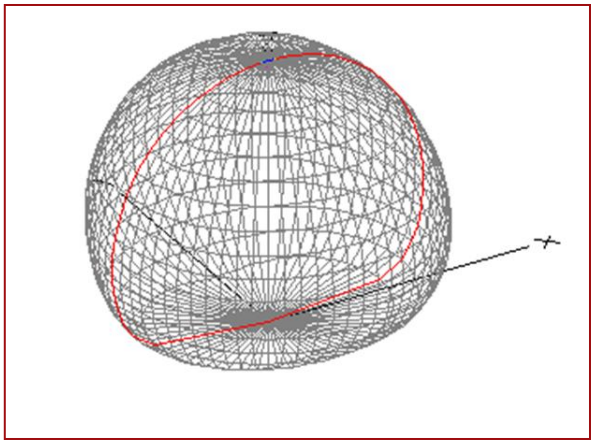
$L = 3\,\lambda/2$

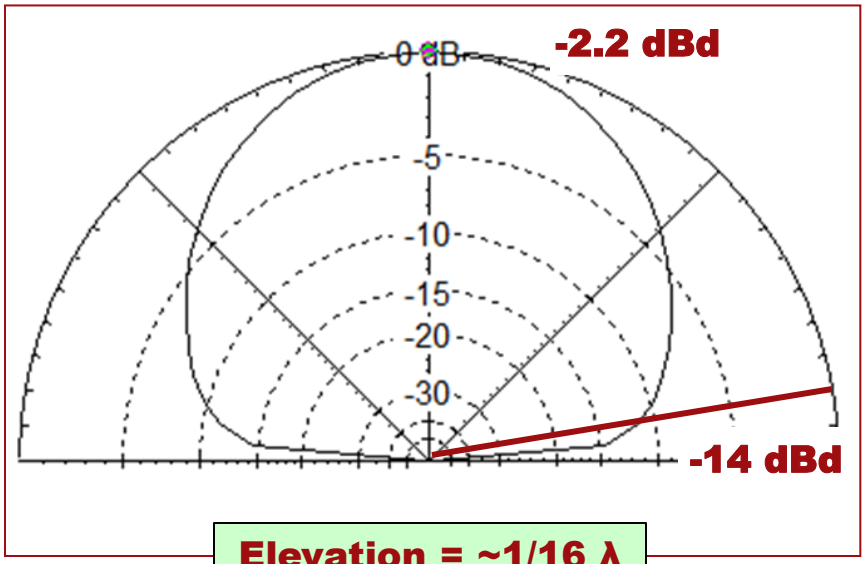
3 half wavelengths → 3 lobes in azimuth pattern

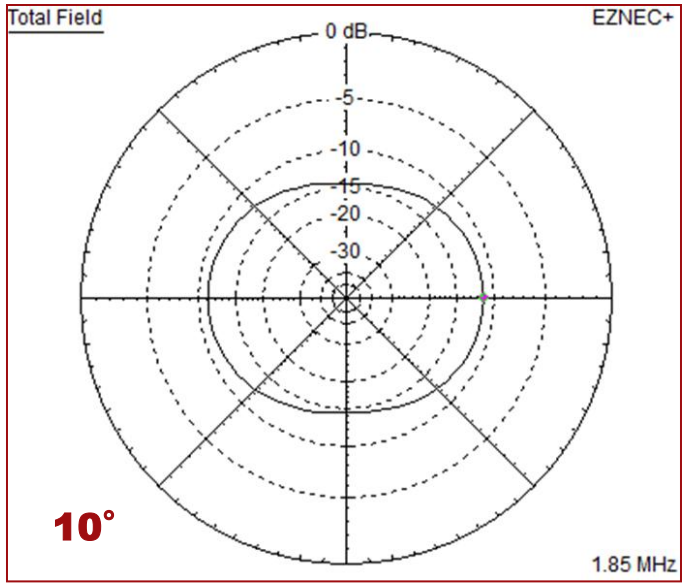
$L = 5\,\lambda/2$

5 half wavelengths → 5 lobes in azimuth pattern

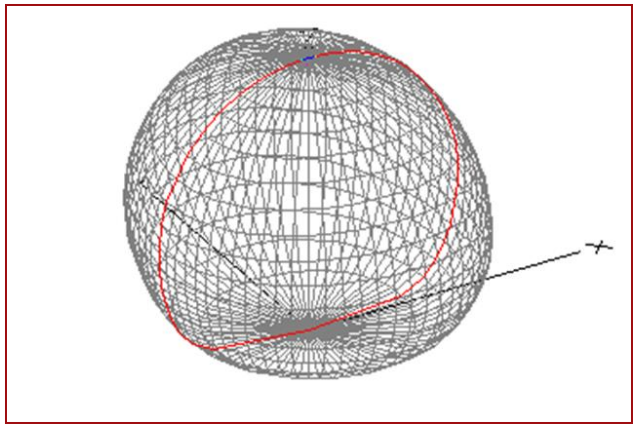
Fan Dipole Details — 160M patterns – 1.85 MHz.

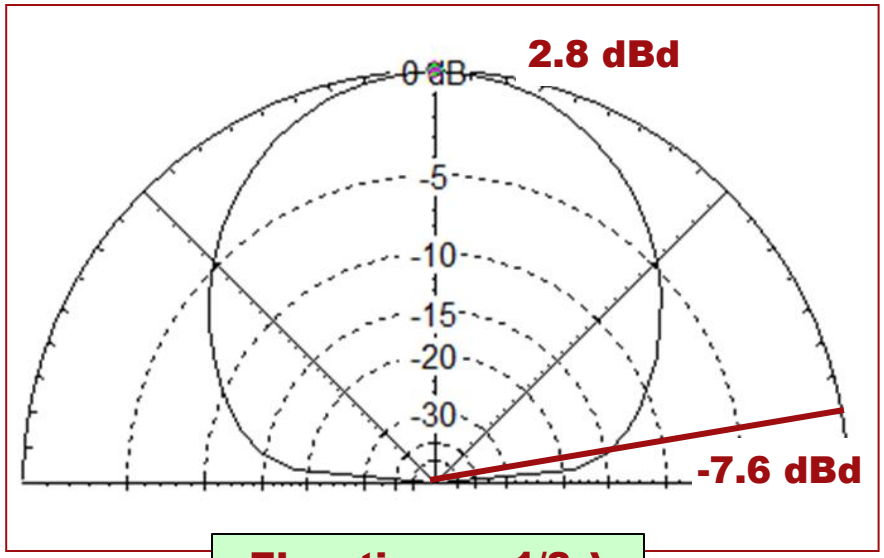




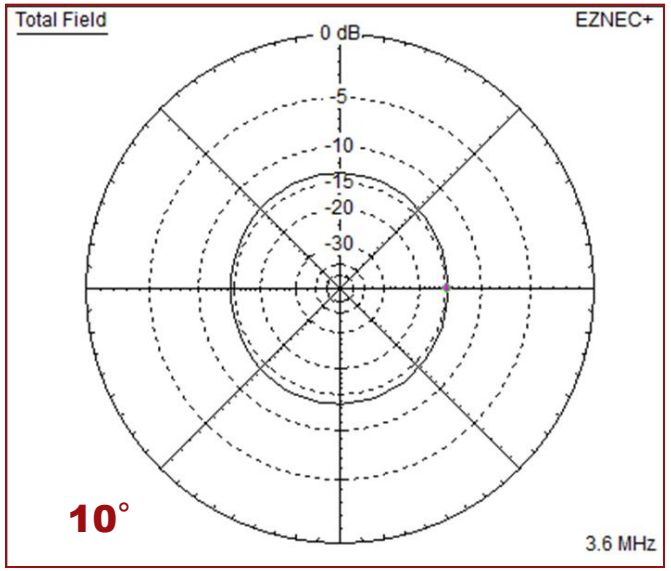


Fan Dipole Details — 80M patterns – 3.6 MHz.

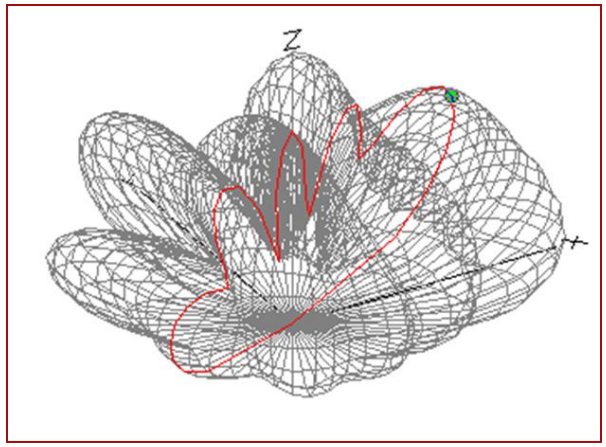


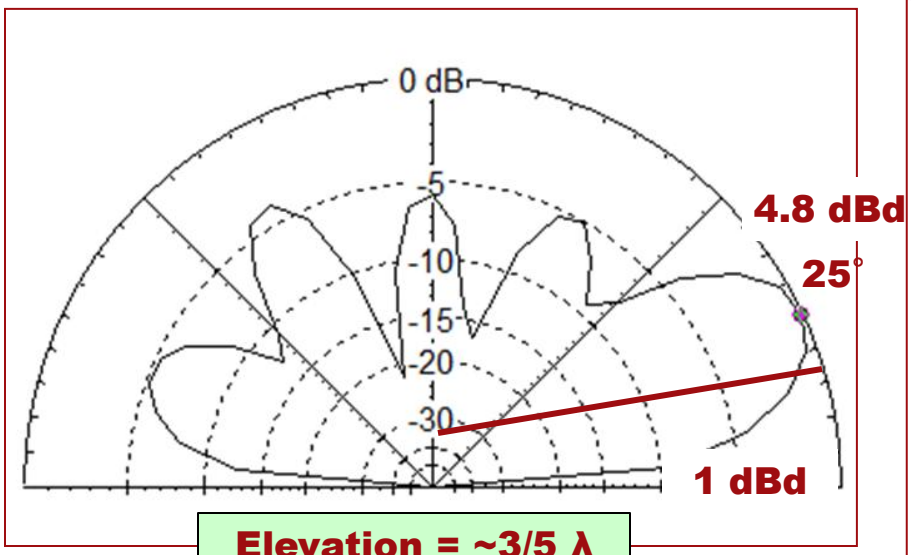


Elevation = ~1/8 λ

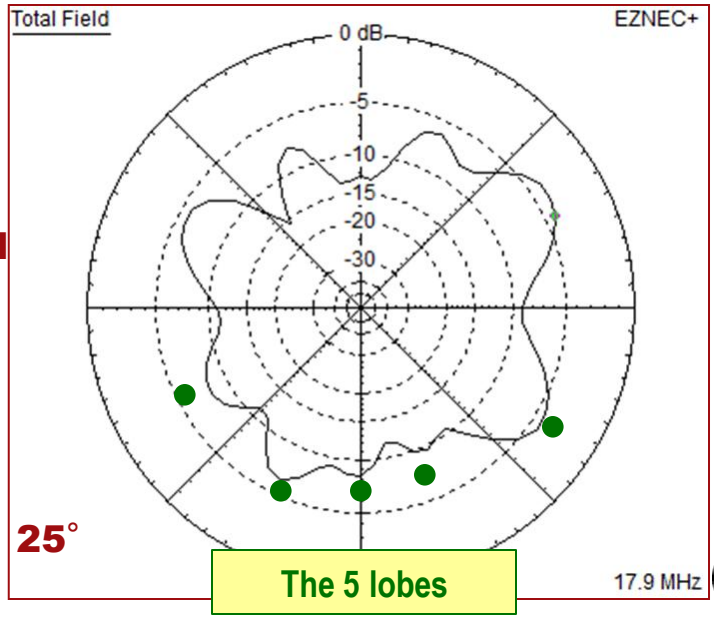


Fan Dipole Details — 17M patterns – 17.9 MHz. [5 $\lambda/_2$]



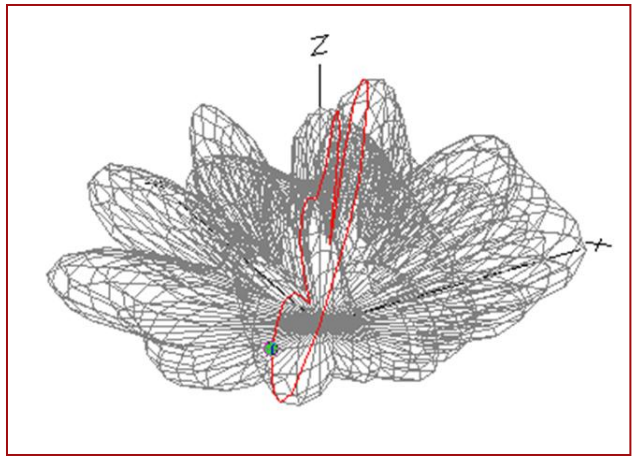


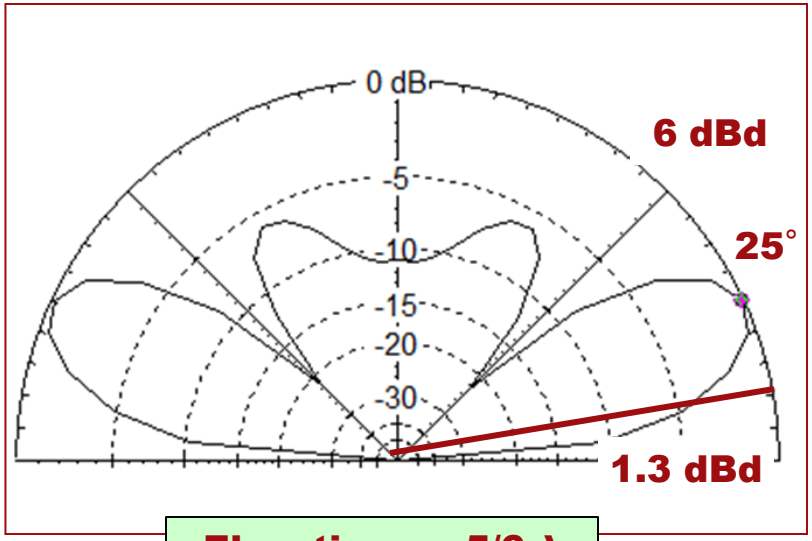
Elevation = ~3/5 λ



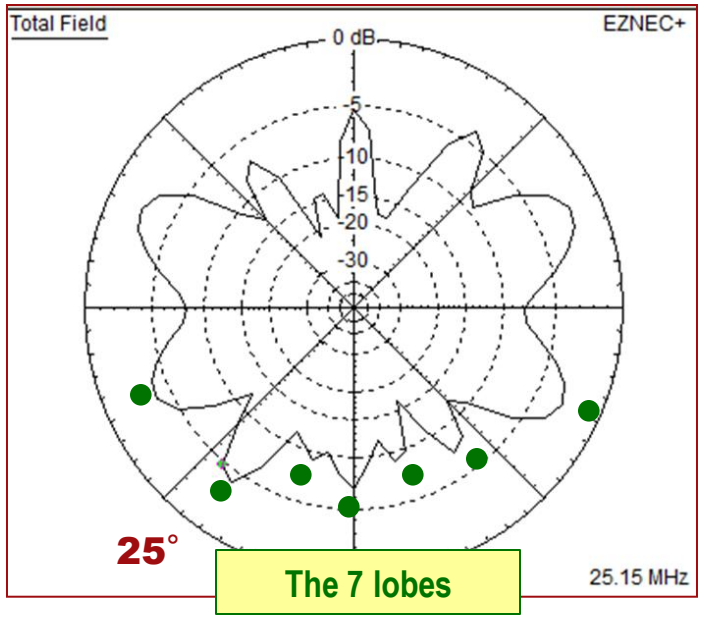
The 5 lobes

Fan Dipole Details — 12M patterns– 25.2 MHz. [7 $\lambda/_2$]





Elevation = ~5/6 λ



The 7 lobes

Current Scorecard

(as of 22 November 2018)

	PH	DIG	CW	TTL
DXCC	227	137	190	245

160	80	40	30	20	17	15	12	10	6
53/50	114	155	137	200	128	167	40/40	162	38/37

DXC
1193

WAS MA	50	50	48 IN WY
WAS ME	50	50	45

33	49 AK	50	49 HI	50	48 DE ME	47	12	50	46
40	49 NV	50	50	50	49 RI	45	14	27	29

6m VUCC
308

Current Scorecard

	PH	DIG	CW	TTL
DXCC	227	137	190	245

160	80	40	30	20	17	15	12	10	6
53/50	114	155	137	200	128	167	40/40	162	38/37

DXC
1193

WAS MA	50	50	48 IN WY
WAS ME	50	50	45

33	49 AK	50	49 HI	50	48 DE ME	47	12	50	46
40	49 NV	50	50	50	49 RI	45	14	27	29

6m VUCC
308

Learn About and Play with Antennas!

They are the BEST [and cheapest] way to increase your RF success.

Thanks