Does

Big Waves + Higher Tides

=

a Storm Erosion Index

?

Joe Pelczarski
Massachusetts Coastal Zone Management

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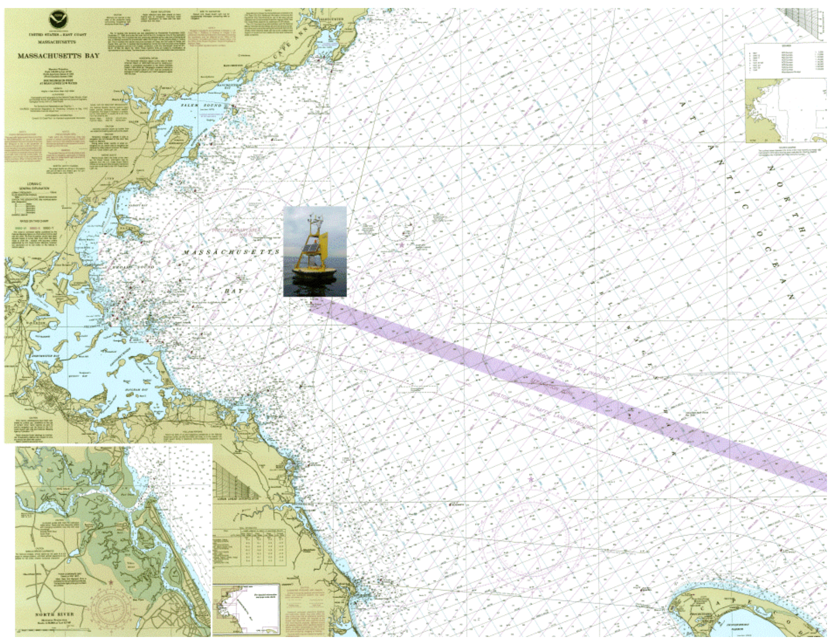
A Dolan and Davis 1992 paper titled
"An Intensity Scale for Atlantic Coast Northeast Storms"
Journal of Coastal Research 8(4) 840-853 noted
"that based on confirmed field evidence that a 5 foot (1.5 m) deep water wave will result in measurable beach face erosion along the North Carolina coast."

Station 44013 [(LLNR 420)]() - BOSTON 16 NM East of Boston, MA

Station 44013 (LLNR 420) - BOSTON 16 NM East of Boston, MA
Boston Approach Lighted Buoy BF NOAA 44013

Owned and maintained by National Data Buoy Center
3-meter discus buoy ARES
4.4 payload
42.346 N 70.651 W (42°20'44" N 70°39'3" W)
Site elevation: sea level
Air temp height: 4 m above site elevation
Anemometer height: 5 m above site elevation
Barometer elevation: sea level
Sea temp depth: 0.6 m below site elevation
Water depth: 61 m



Data Availability for 44013 - BOSTON 16 NM East of Boston, MA

BUOY ID PRIMARY
(EARLIER ID)
PLATFORM CLASS

LAT/LON	BARO	WINDS	WAVE			TEMPERATURE			
OPER. PERIOD	PRESS	SPD/DIR	CONT	NONDIR	DIR	AIR	SEA	DPT	OTHER
LNB/DACT									
42.4 N./70.8 W.									
8/84-5/86	X	X				X	X		
6/86-7/87	X	X		X		X	X		
10/87-4/88	X	X		X		X	X		
5/88-11/88	X			X		X	X		
12/88-8/90	X	X		X		X	X		
9/90	X			X		X	X		
10/90-9/93	X	X		X		X	X		
3D/DACT									
10/93-6/94	X	X		X	X	X	X		
7/94-8/94	X			X	X	X	X		
9/94	X	X		X	X	X	X		
10/94-10/95	X	X		X	X	X			
11/95-5/97	X	X		X	X	X	X		
6/97-7/97	X	X		X	X	X			
11/97-04/99	X	X		X		X	X		
05/99-01/01	X	X	X	X		X	X	X	
02/01-04/01	X			X		X	X	X	NO WIND DIR
05/01-06/03	X	X	X	X		X	X	X	

Boston, MA Station ID: 8443970
***Latitude:* 42° 21.2' N**
***Longitude:* 71° 3.2' W**
Mean Range: **9.49 ft.**
Diurnal Range: **10.27 ft.**
***Established:* May 3 1921**
***Present Installation:* Nov 16 1988** ***NOAA Chart #:* 13272**
***Time Meridian:* 75 W**

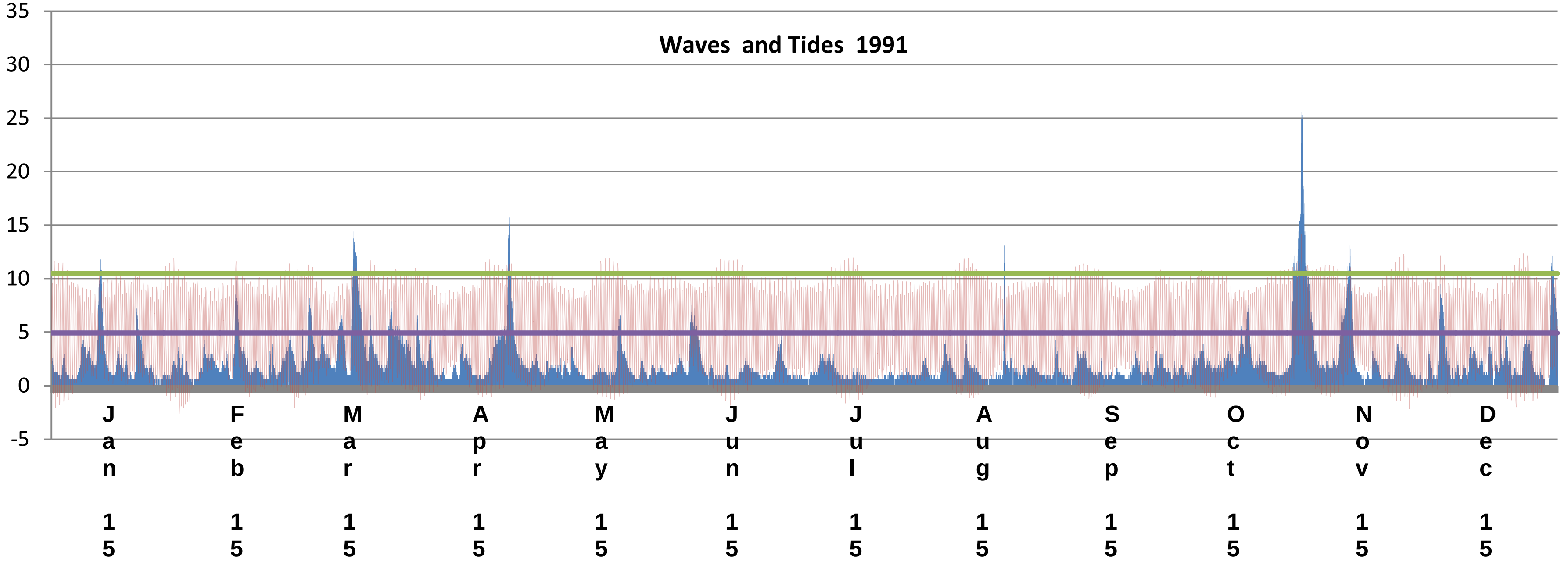
Boston

Flood Categories (in feet)

Major Flood Stage:	**16**
Moderate Flood Stage:	**15**
Flood Stage:	**13.5**
Action Stage:	**12**

16	Major widespread coastal flooding is expected. Evacuations of low lying coastal areas is likely along with numerous closures of coastal roadways within several hours of high tide. People living in vulnerable coastal areas must take action now to protect life and property.
14.5	Significant flooding of low lying coastal locations is expected from Revere and Winthrop southward through Hull. Road closures and some evacuations of coastal sections is likely. Large swells and wave action will produce significant beach erosion.
14	Flooding of low lying coastal locations is expected from Revere and Winthrop southward through Hull. Road closures and some evacuations of coastal sections may be required. Large swells and wave action will produce minor to moderate beach erosion.
13.5	Minor flooding of low lying coastal locations is expected from Revere and Winthrop southward through Hull. The combination of high tides and large swells will result in wash over onto coastal roadways and some road closures may occur around the time of high tide.

Coastal flooding can occur at a stage of 12 feet, when onshore winds are present along with 20 foot seas. Boston Harbor gage data and forecasts are in feet Mean Lower Low Water (MLLW).



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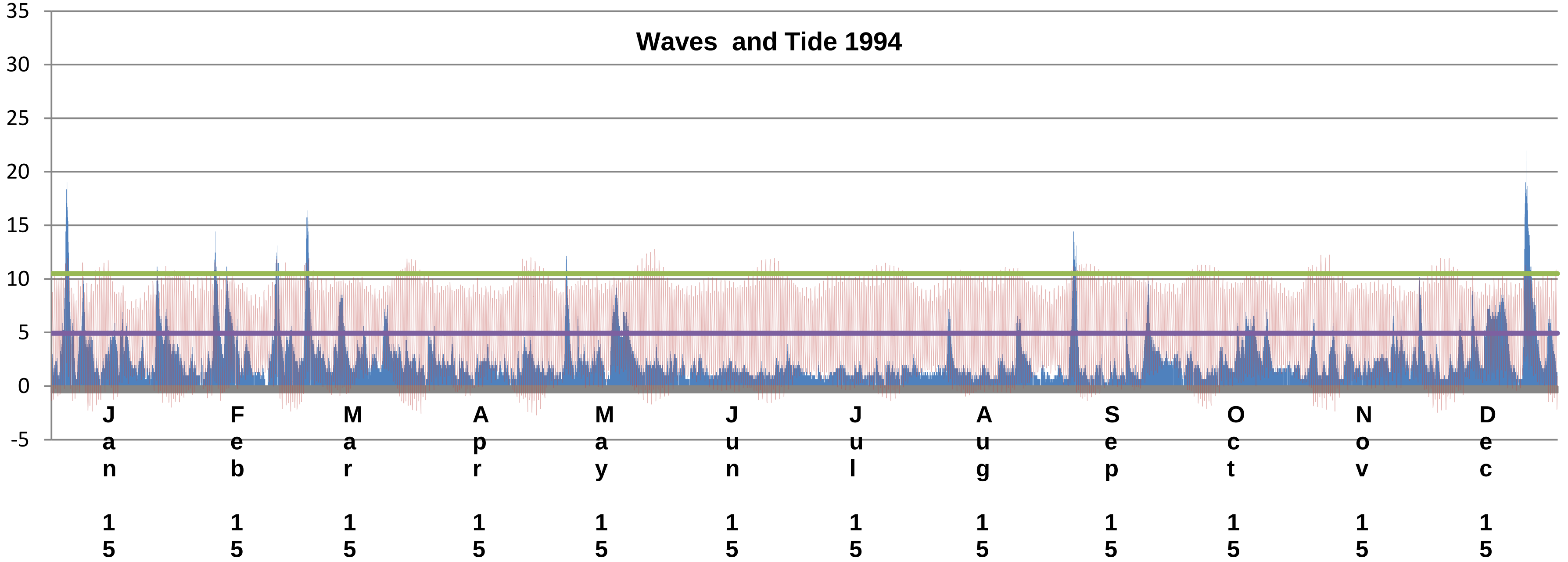

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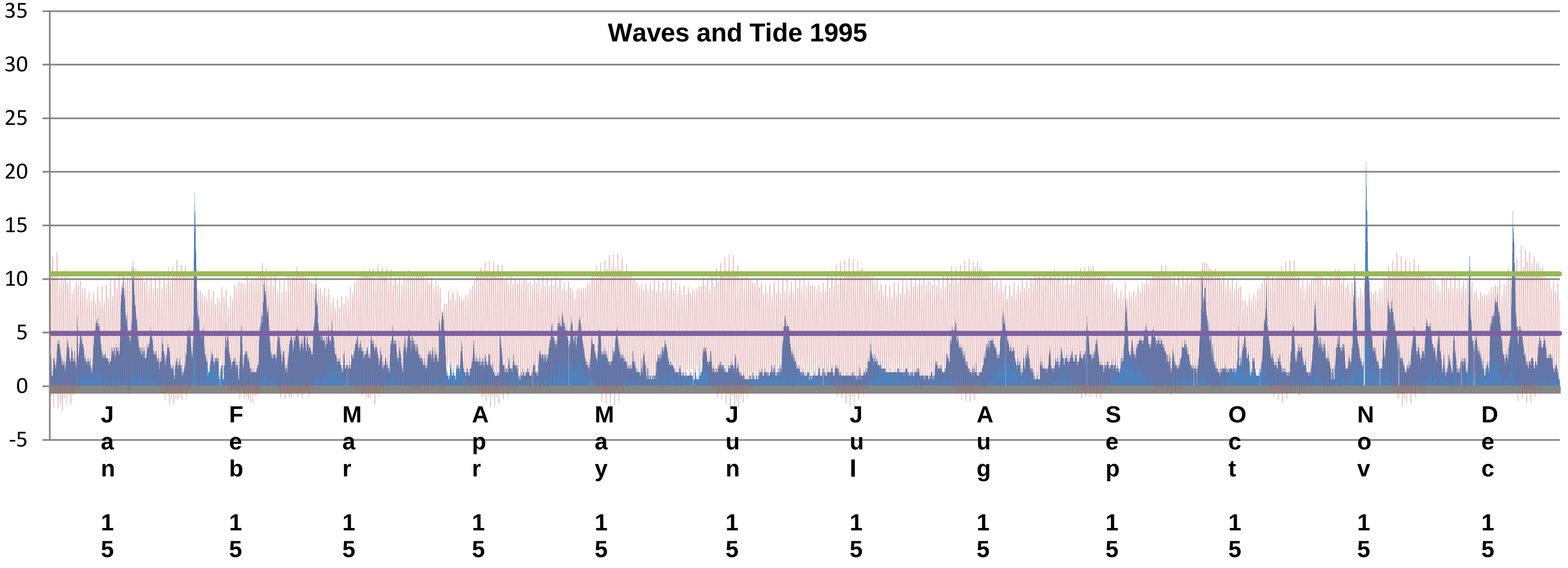
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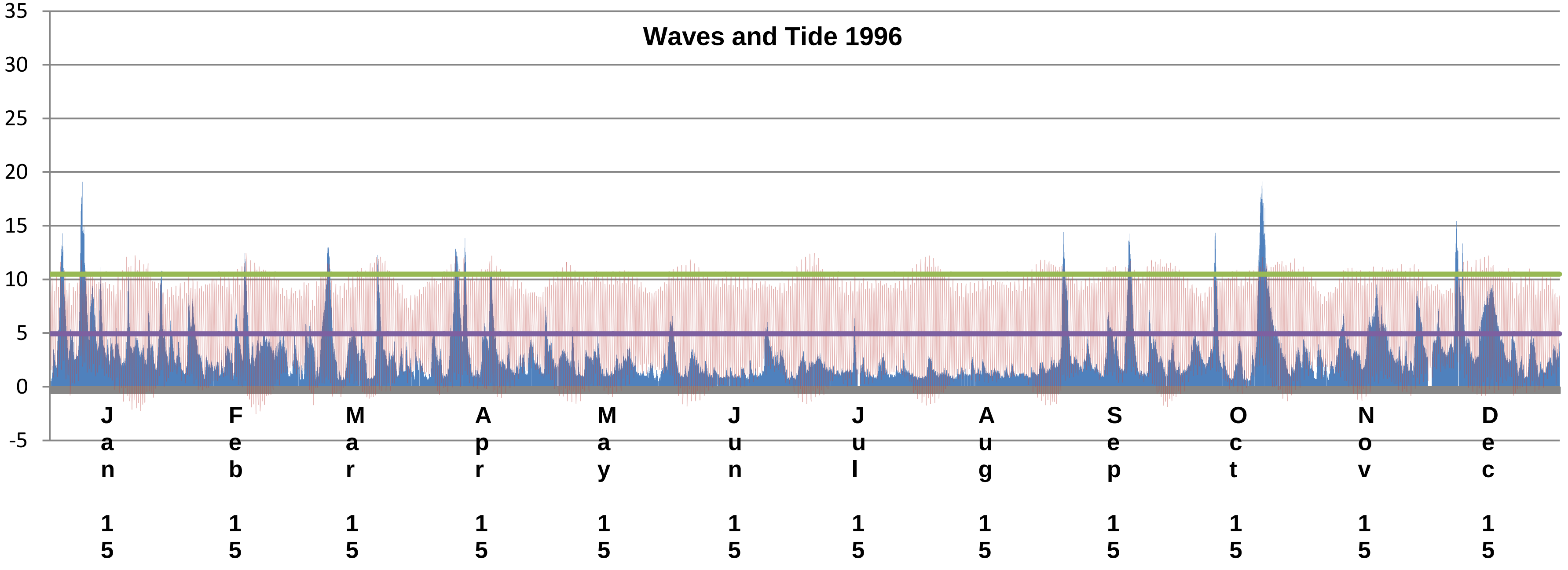
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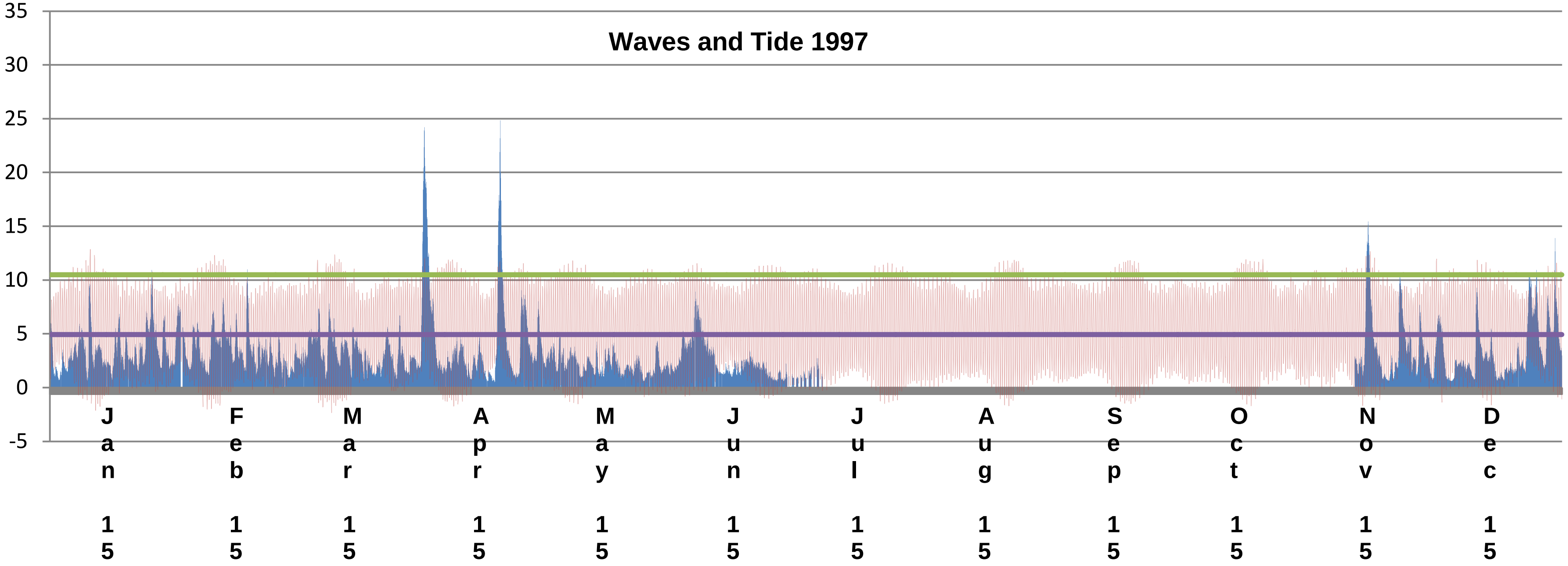
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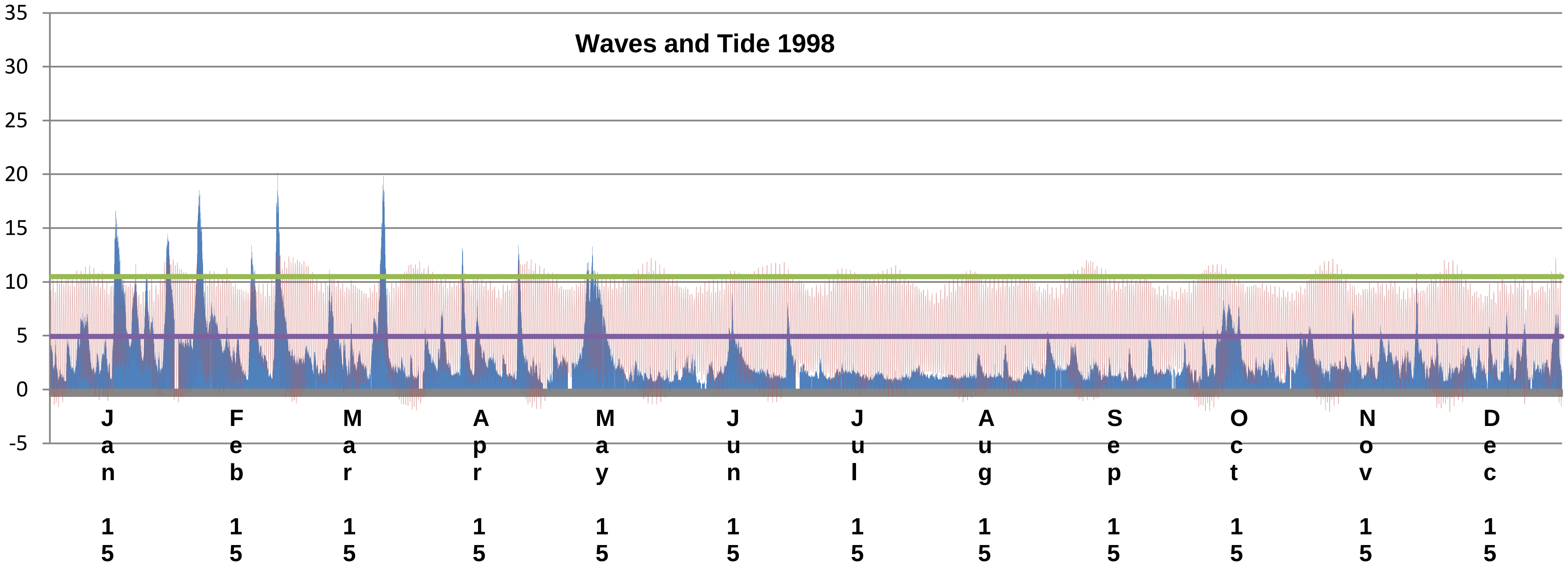
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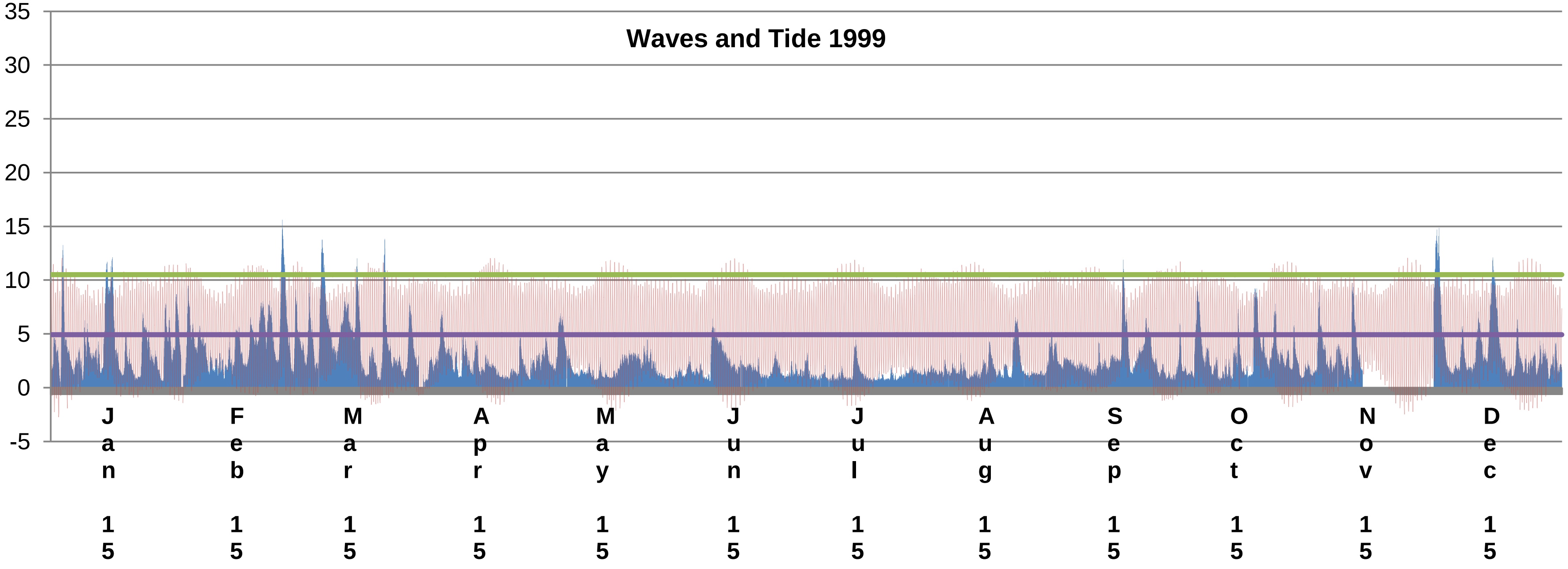
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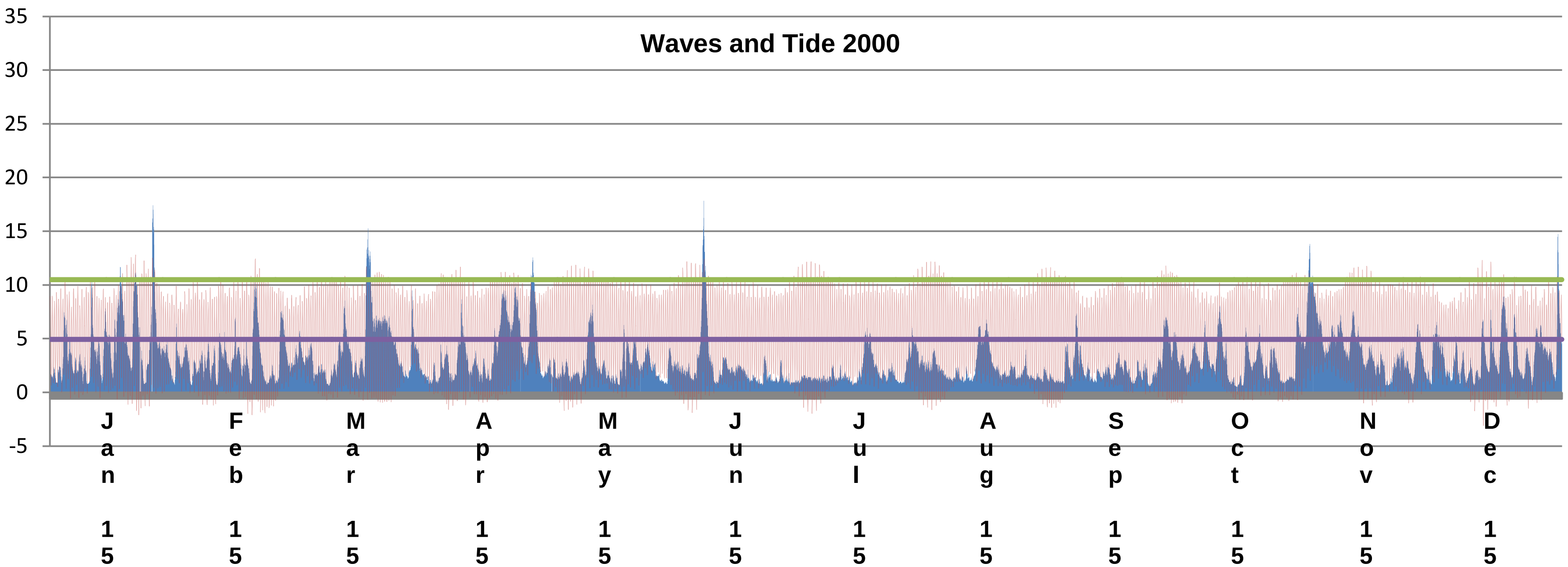
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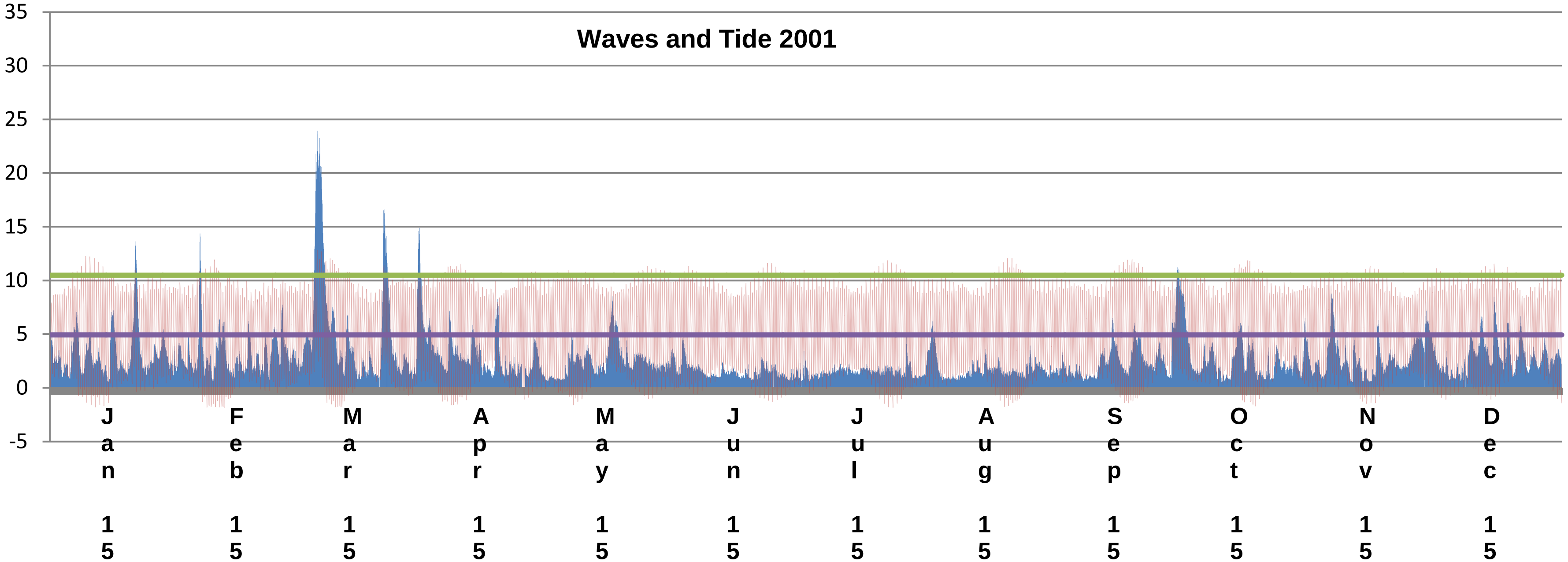
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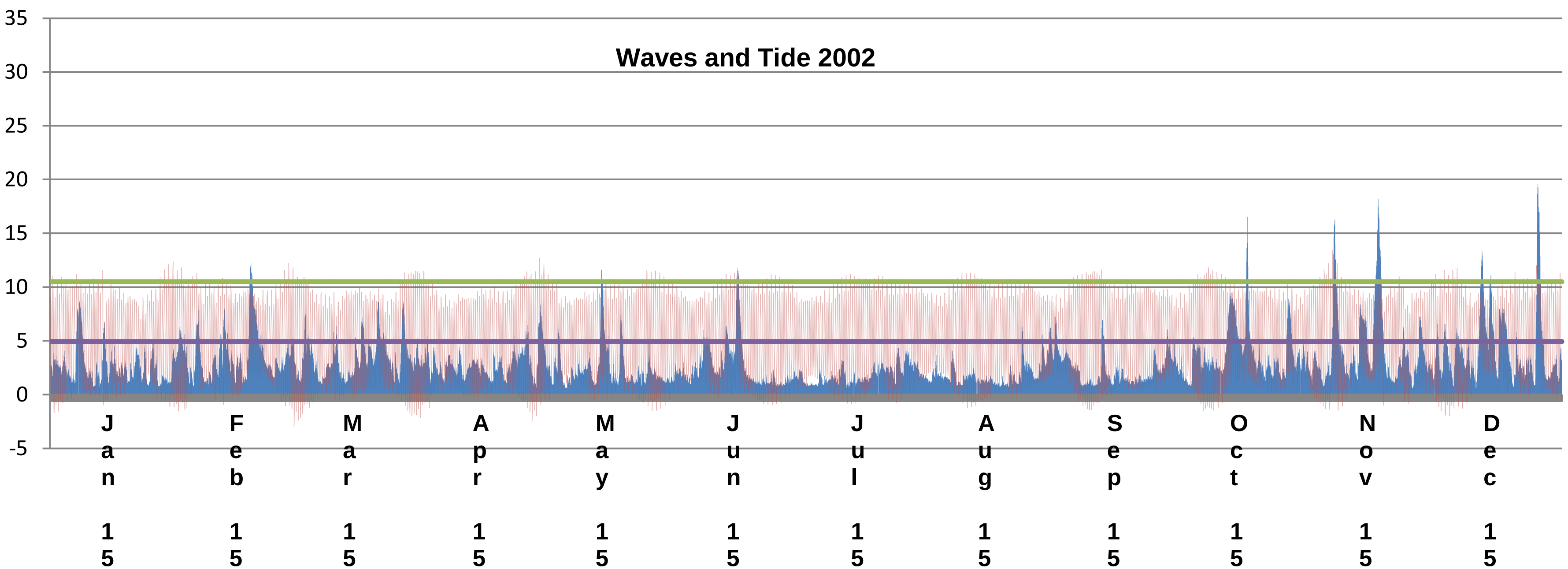
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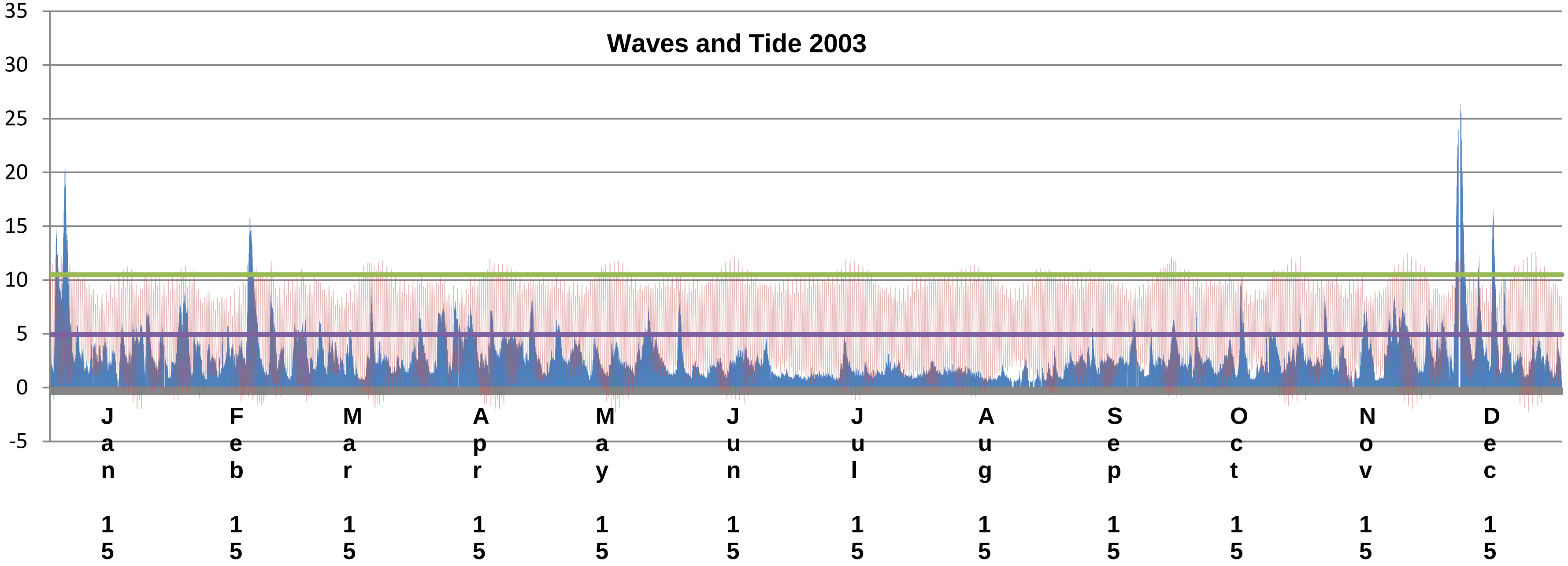
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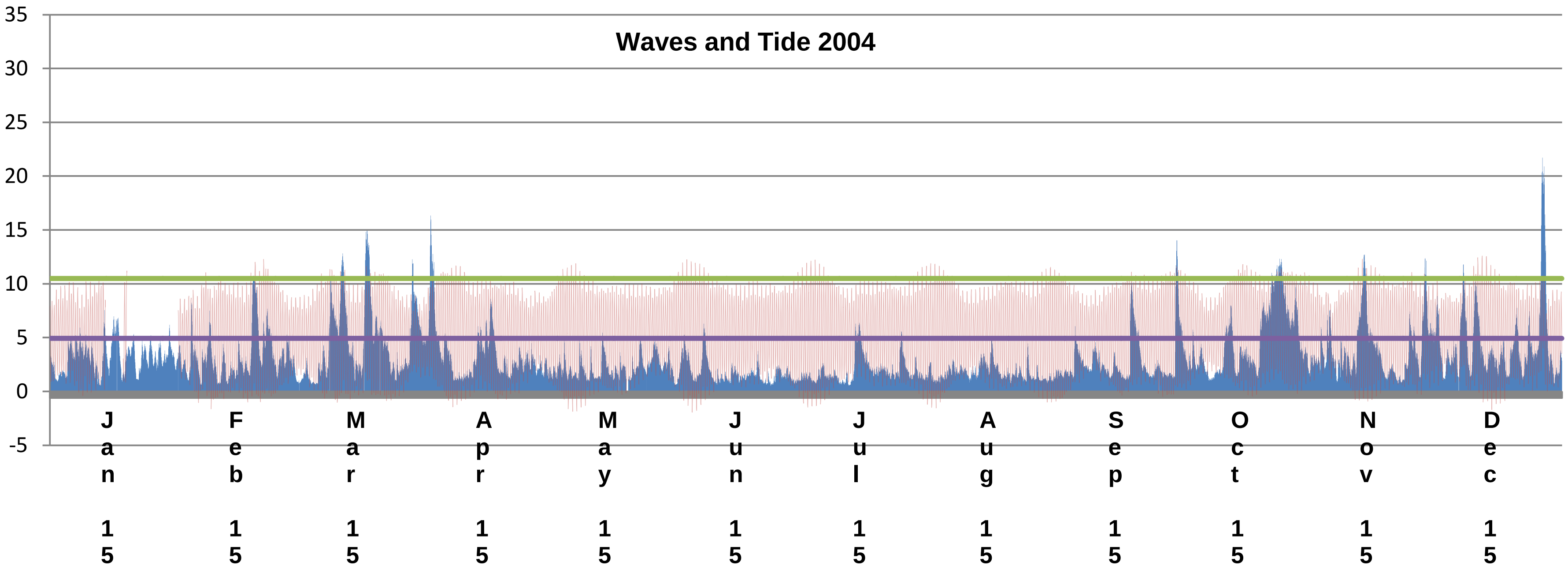
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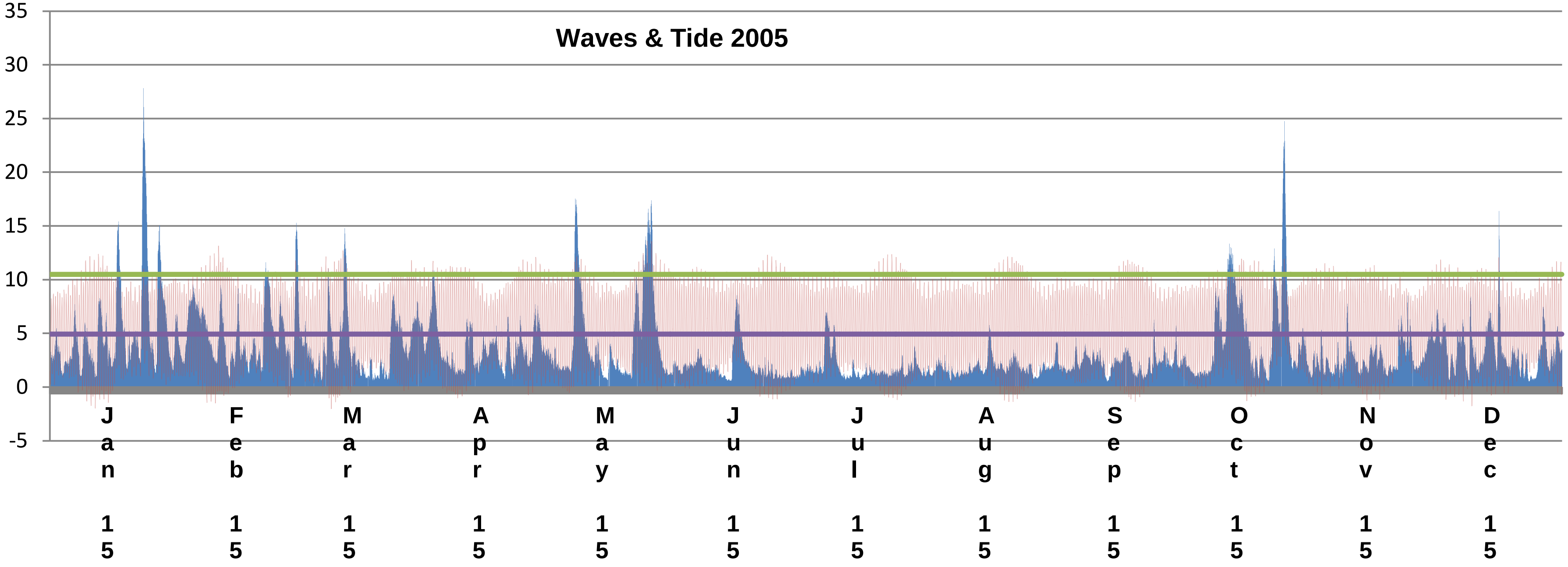
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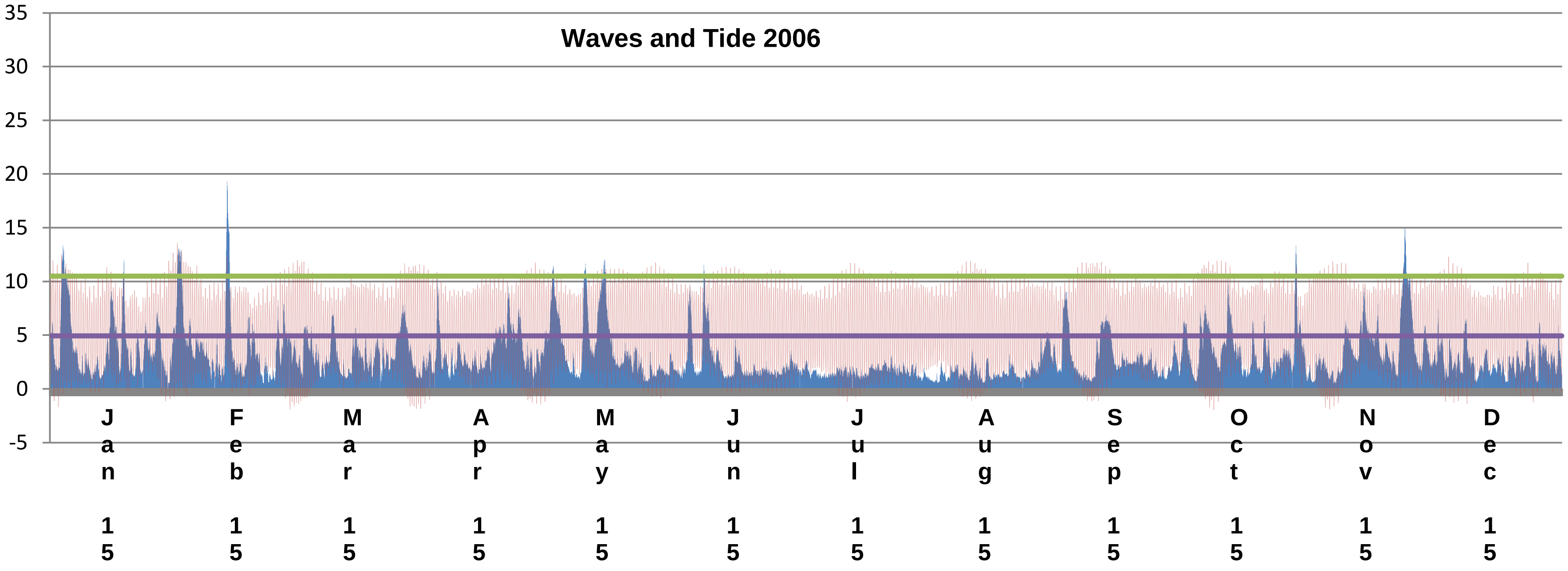
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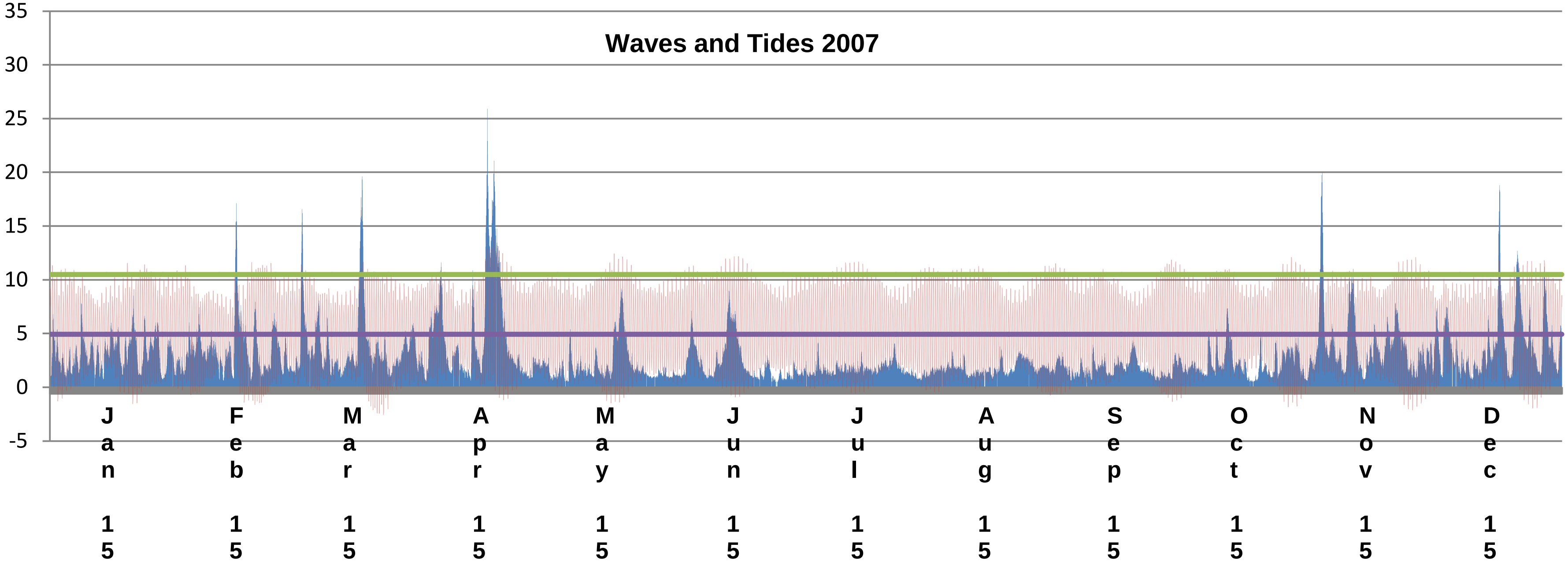
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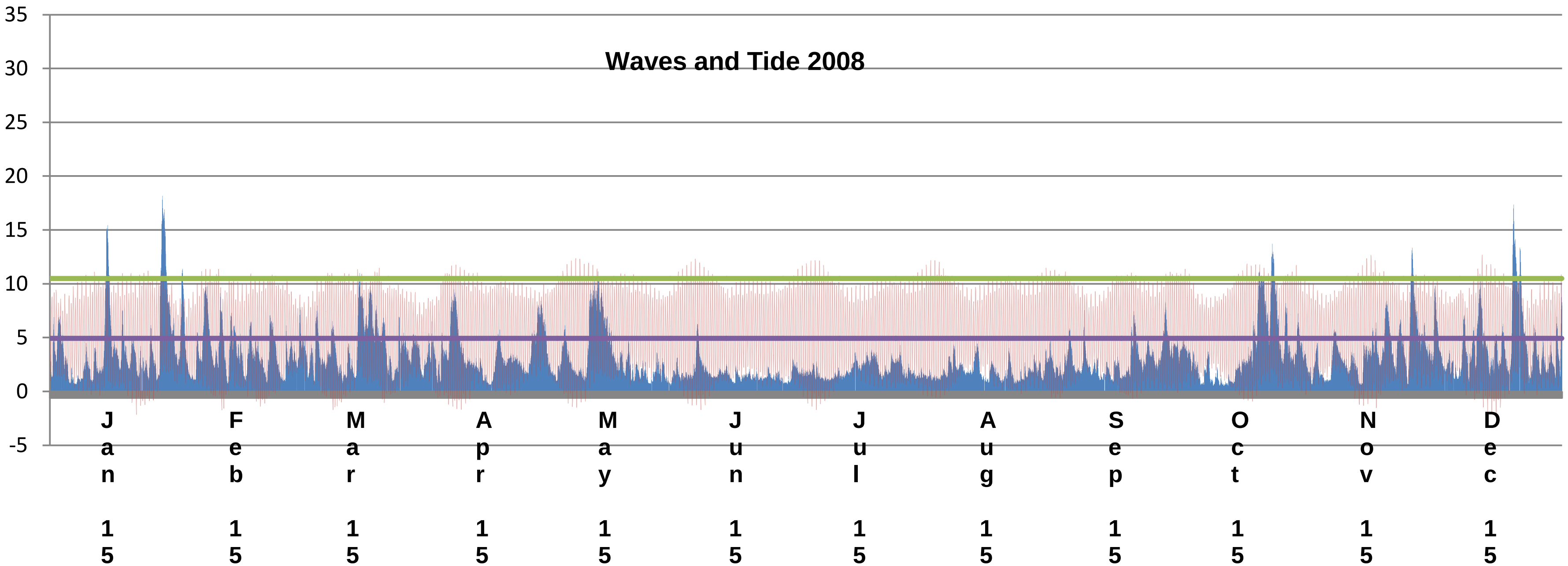
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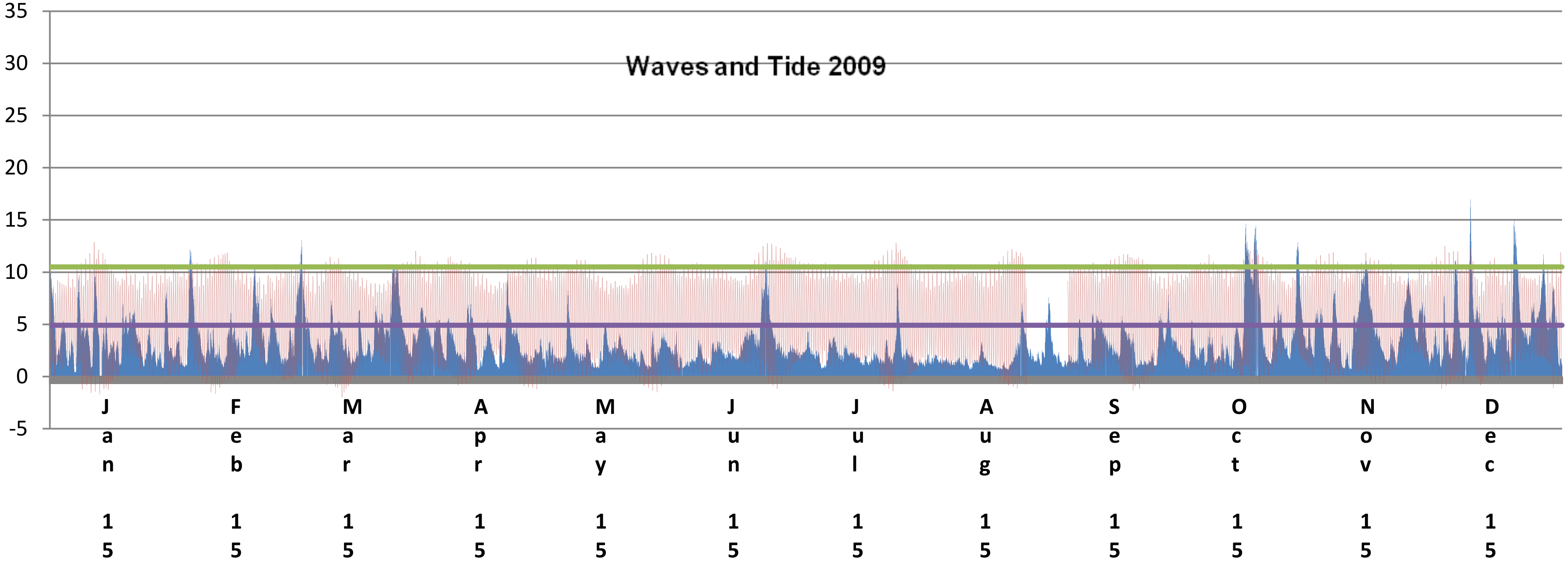
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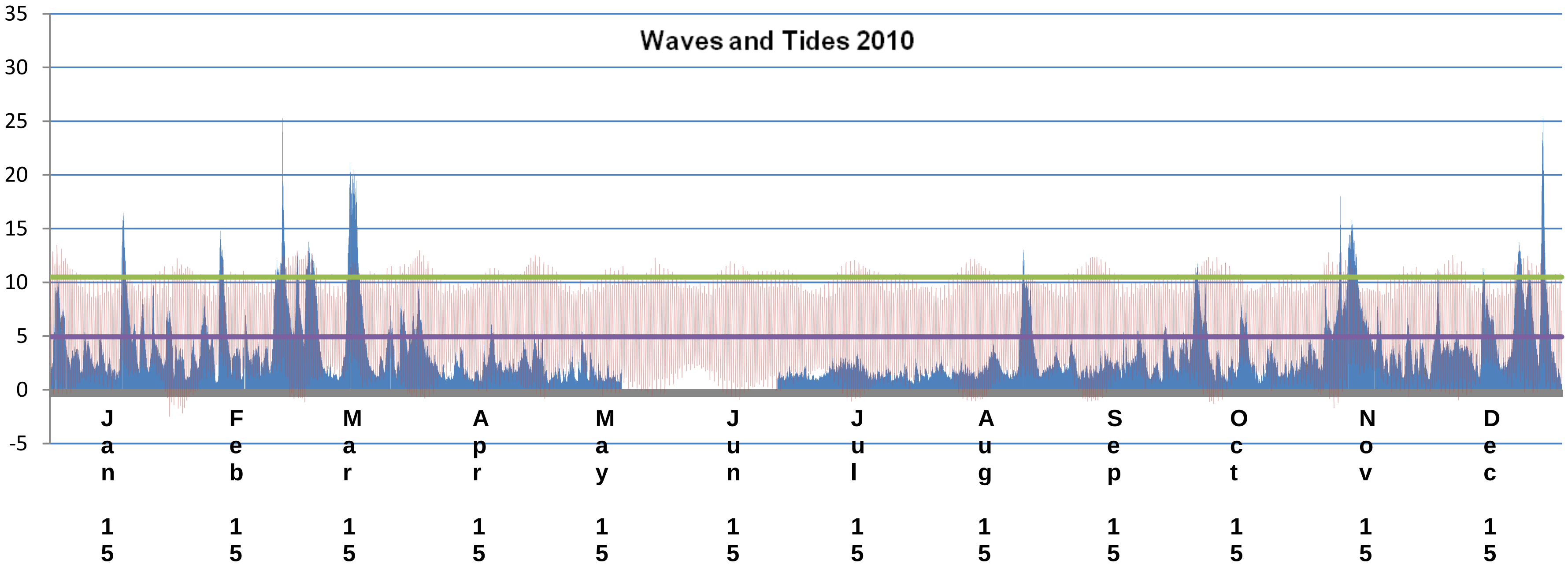
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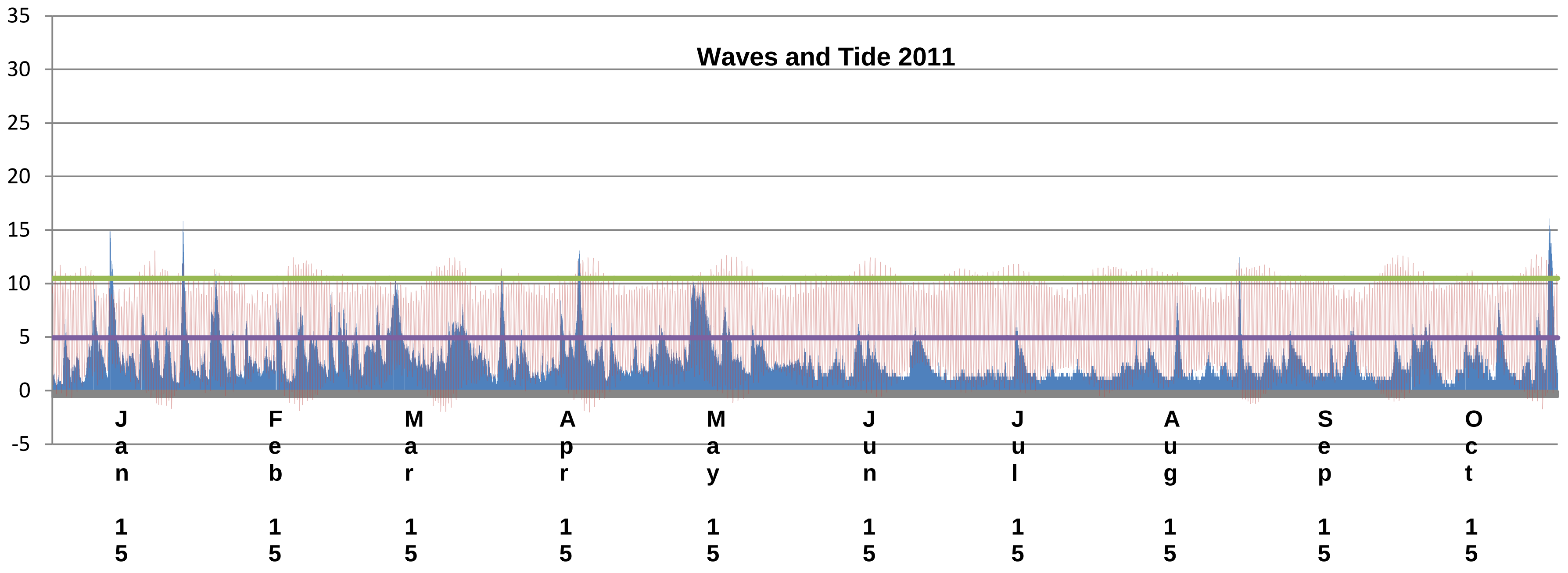
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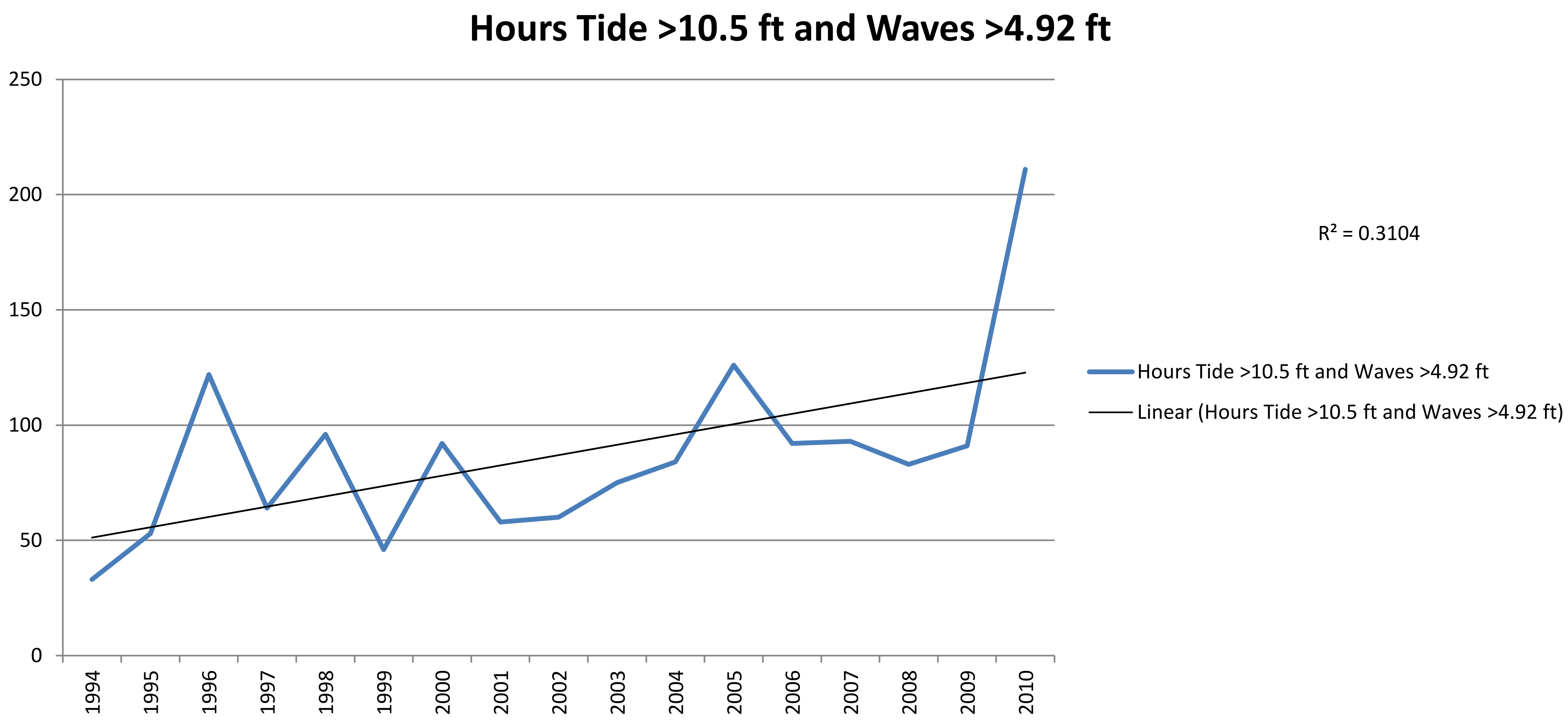
Year	Predicted Tide Hours > 10.5 ft MLLW	Observed Tide Hours >10.5 ft MLLW	Hours Waves >4.92 ft (1.5 m)	Hours Tide >10.5 ft and Waves >4.92 ft
1994	316	251	961	32
1995	307	334	891	51
1996	336	432	1217	121
1997	365	380	828	64
1998	355	417	1201	96
1999	313	305	1048	49
2000	261	294	1309	92
2001	301	273	828	59
2002	296	298	1063	60
2003	264	338	1135	76
2004	201	274	1330	82
2005	233	403	1607	129
2006	262	374	1282	93
2007	262	348	1034	95
2008	204	345	1381	84
2009	240	406	1523	85
2010	304	596	1622	206
	4820	6068	20260	1474


Hours Tide >10.5 ft and Waves >4.92 ft
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1994
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2003
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2006
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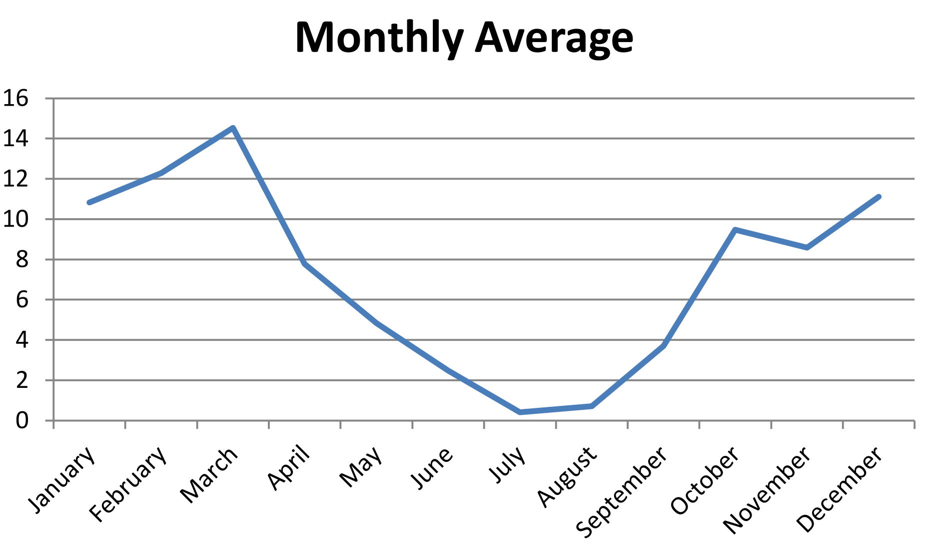
2008
2009
2010
R² = 0.3104
Hours Tide >10.5 ft and Waves >4.92 ft
Linear (Hours Tide >10.5 ft and Waves >4.92 ft)

1994-2010

Total	Avg		cumulative	Highest	Year	Lowest	Year													
184	10.82	January	11	25	2006	0	2004													
209	12.29	February	23	34	2010	1	2009													
247	14.53	March	38	65	2010	2	1995													
132	7.765	April	45	36	2007	0	1994	1995	1999											
82	4.824	May	50	38	2005	0	1994	1995	1996	1997	1999	2001	2004	2009	2010					
42	2.471	June	53	11	2009	0	1994	1995	1996	1999	2001	2003	2005	2010						
7	0.412	July	53	3	2009	0	1994	1995	1996	1997	1998	1999	2001	2002	2003	2004	2006	2007	2008	2010
12	0.706	August	54	6	2011	0	1994	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	
63	3.706	September	58	15	1996	0	1995	1997	1998	2005	2007	2010								
161	9.471	October	67	19	2009 2004 1996	0	1994	1997												
146	8.588	November	76	30	2010	0	1994	1999												
189	11.12	December	87	37	2010	0	2006													
1474	86.71			206	2010	33	1994													


Monthly Average
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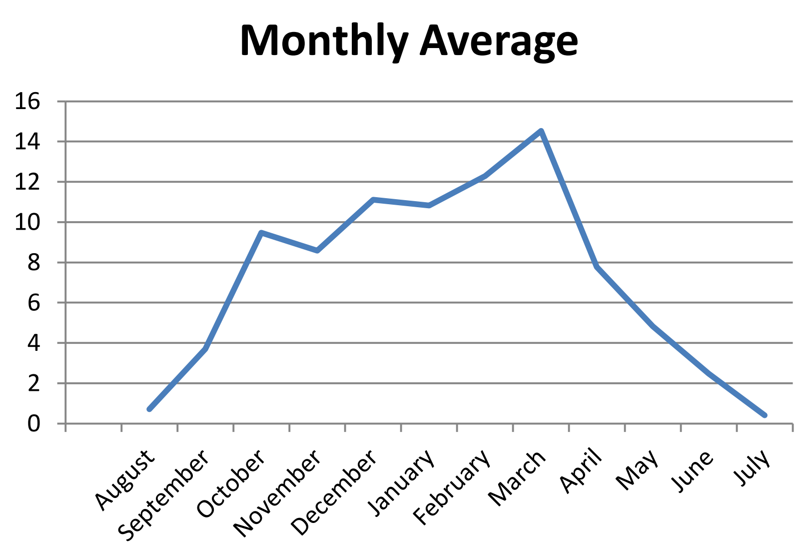
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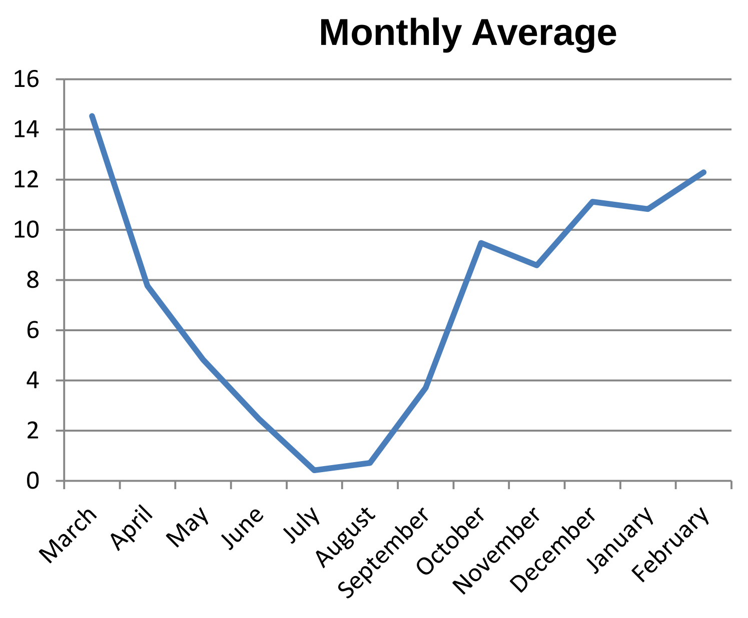
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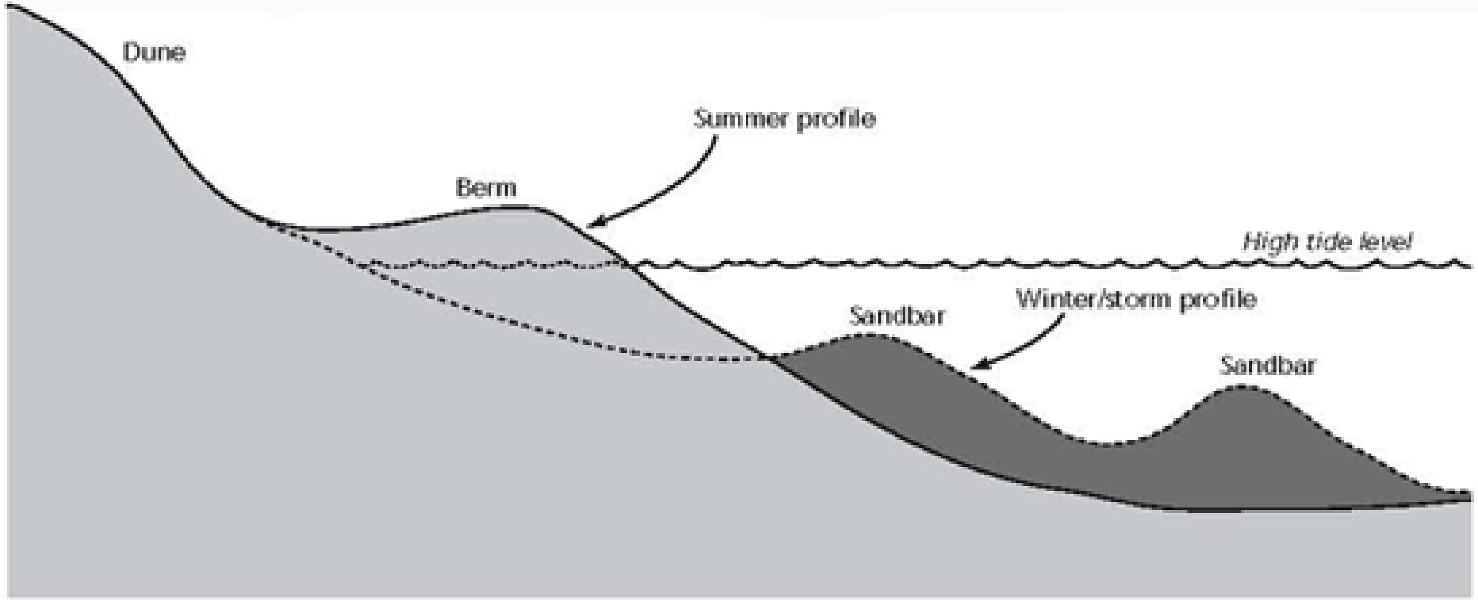
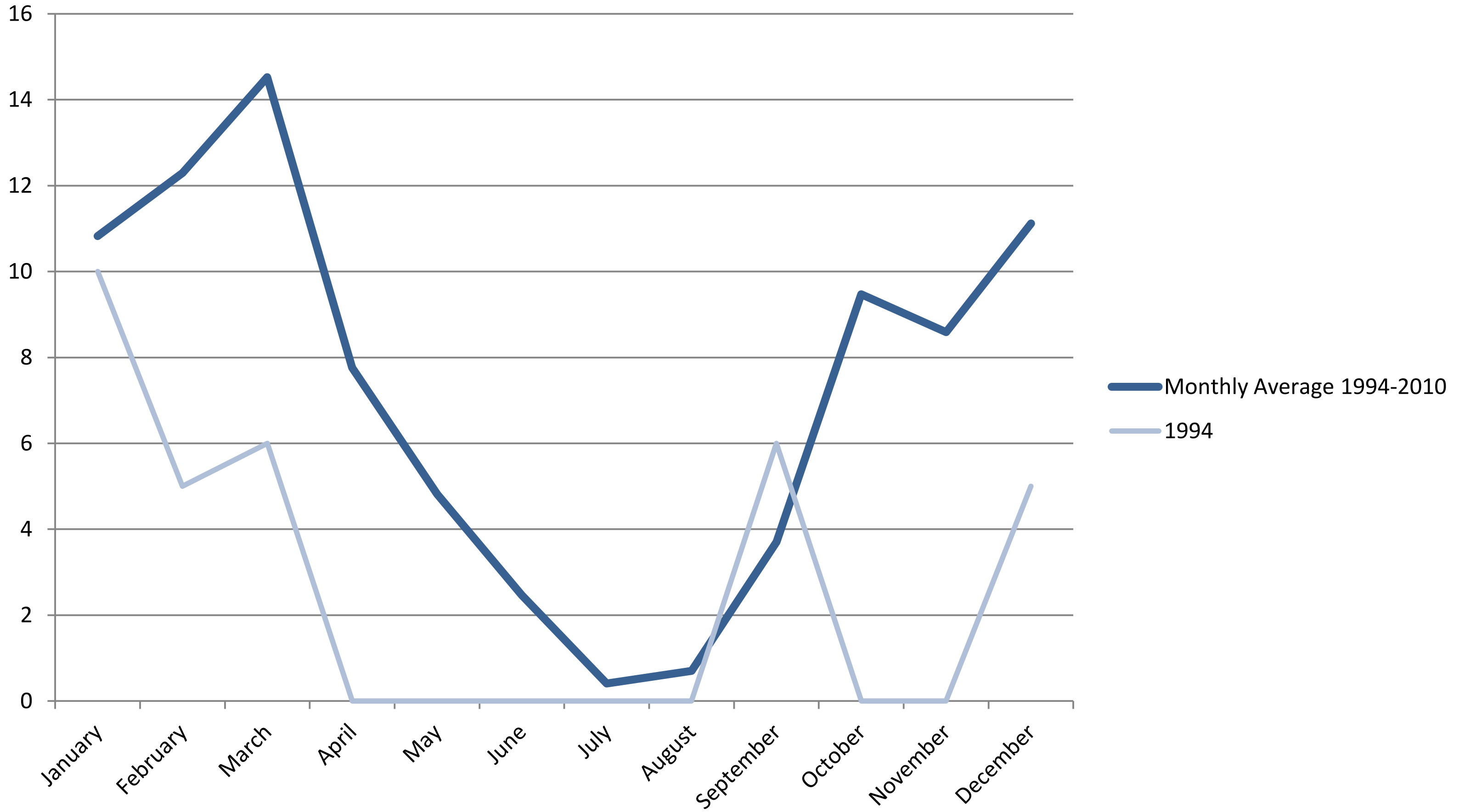


Figure A: Typical summer and winter beach and dune profiles.

Equilibrium beach profiles

The equilibrium beach profile results from steady wave forcing during the seasonal cycle.
Summer wave conditions move sand onto the beach.
Winter storm waves move sand offshore.
Unusually large storm events result in a disequilibrium profile, and sand may be permanently lost to deep water.

Summer and winter beach profiles are expressions of the seasonal cycle of wave energy.
Due to storms, waves are larger and more energetic in winter than summer.
Long periods of stormy weather, such as El Niño winters, erode beaches to the underlying cobbles or bedrock and deposit sand far offshore in deep water, leaving the beach in disequilibrium.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Monthly Average 1994-2010
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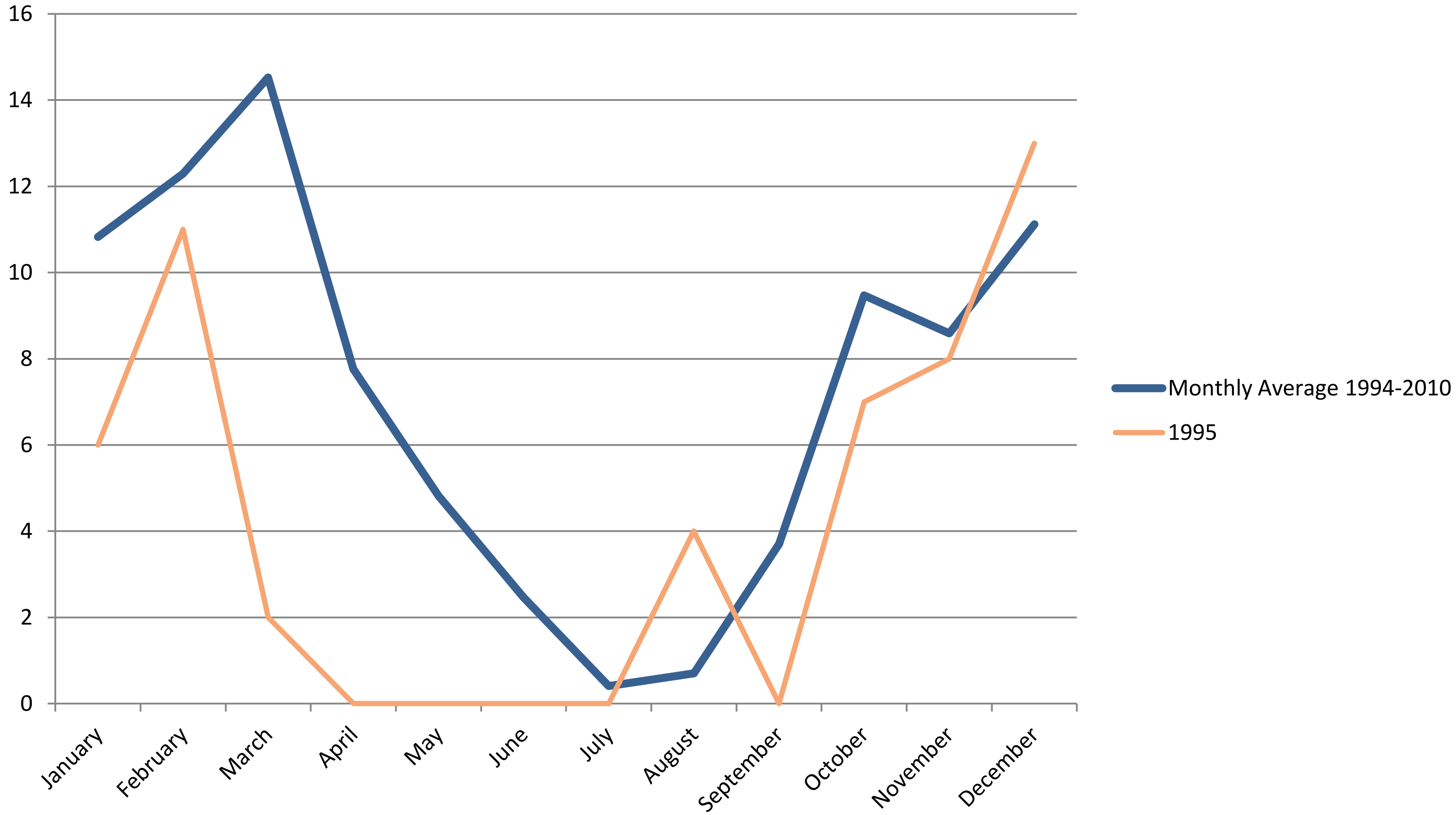

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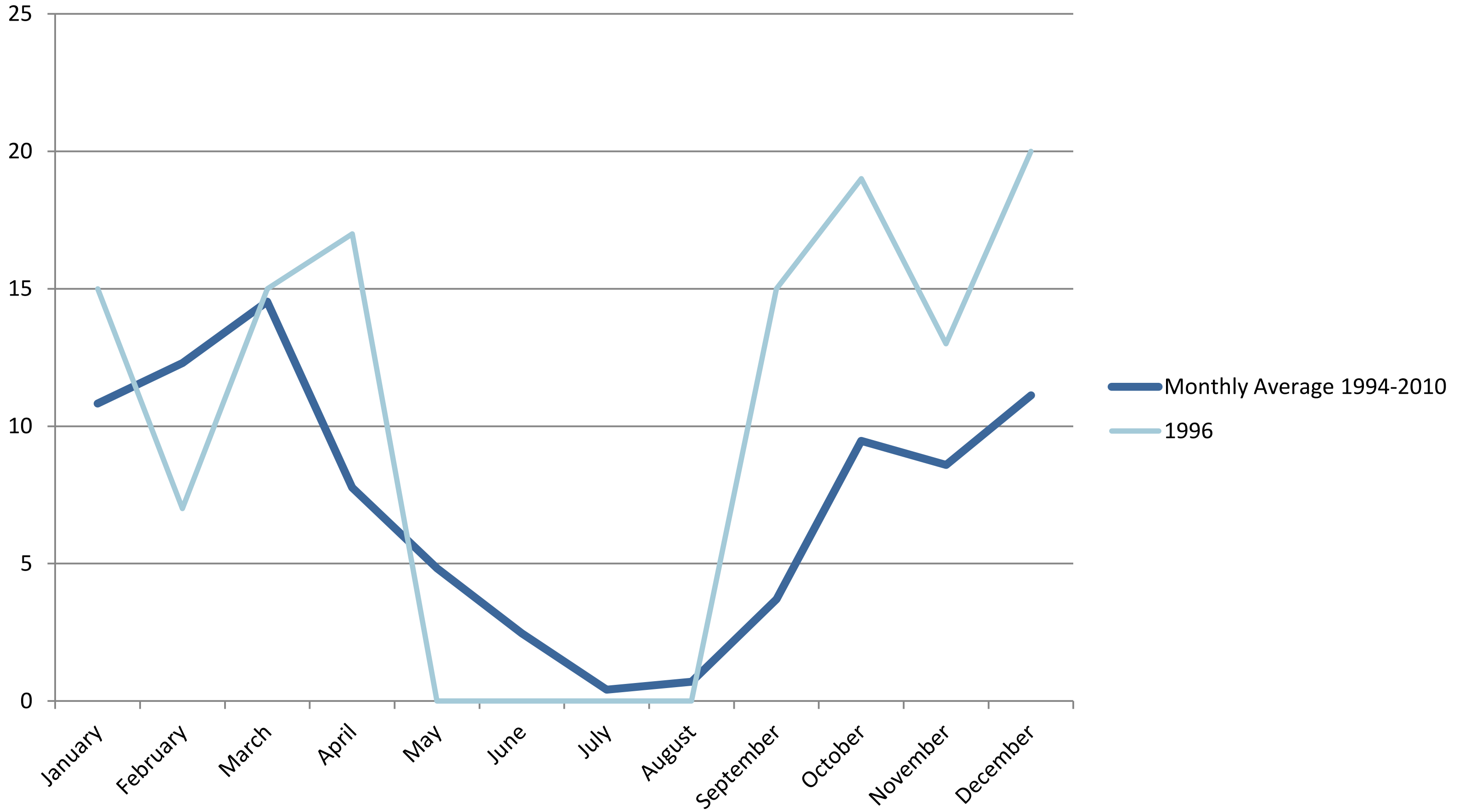

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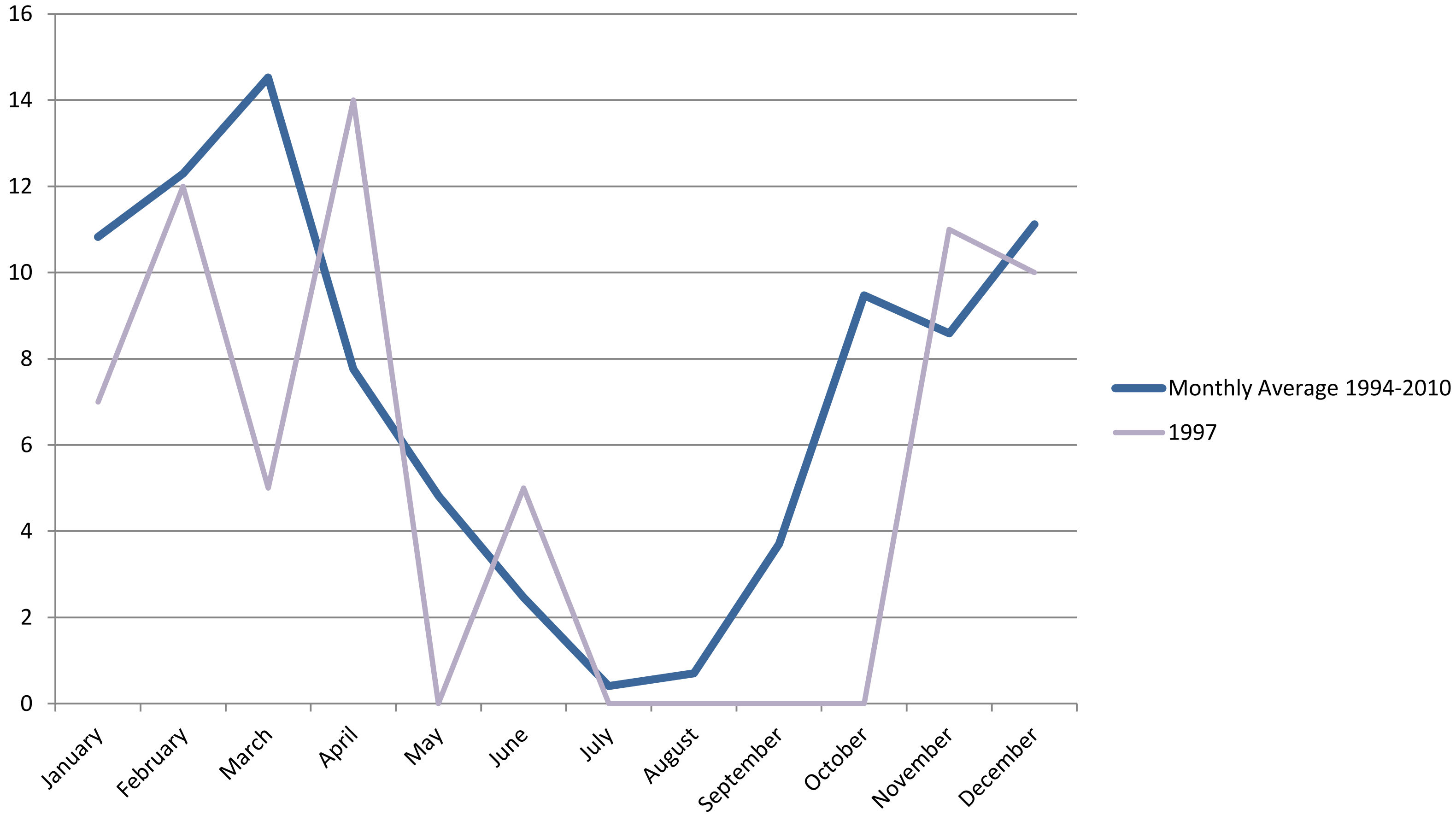
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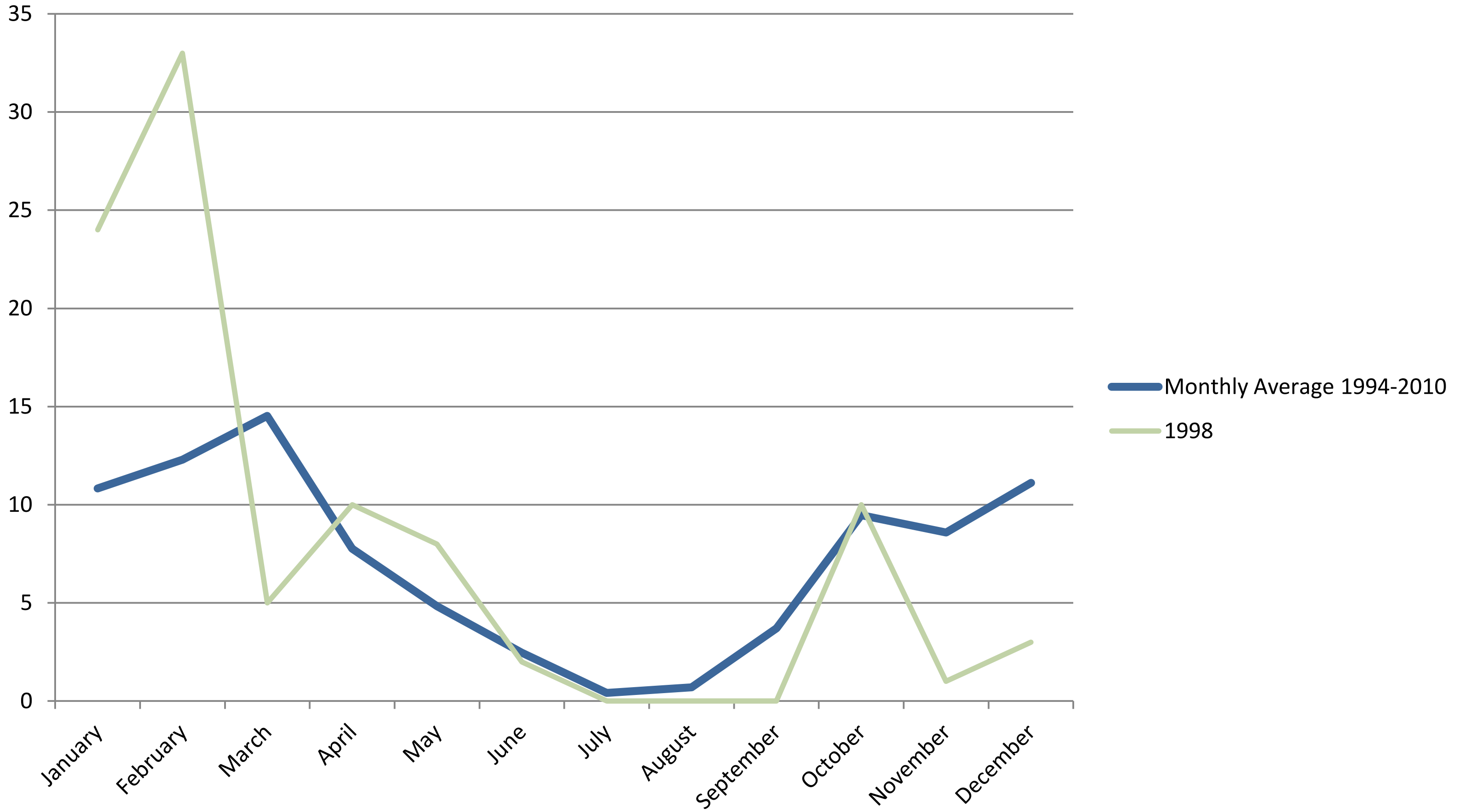
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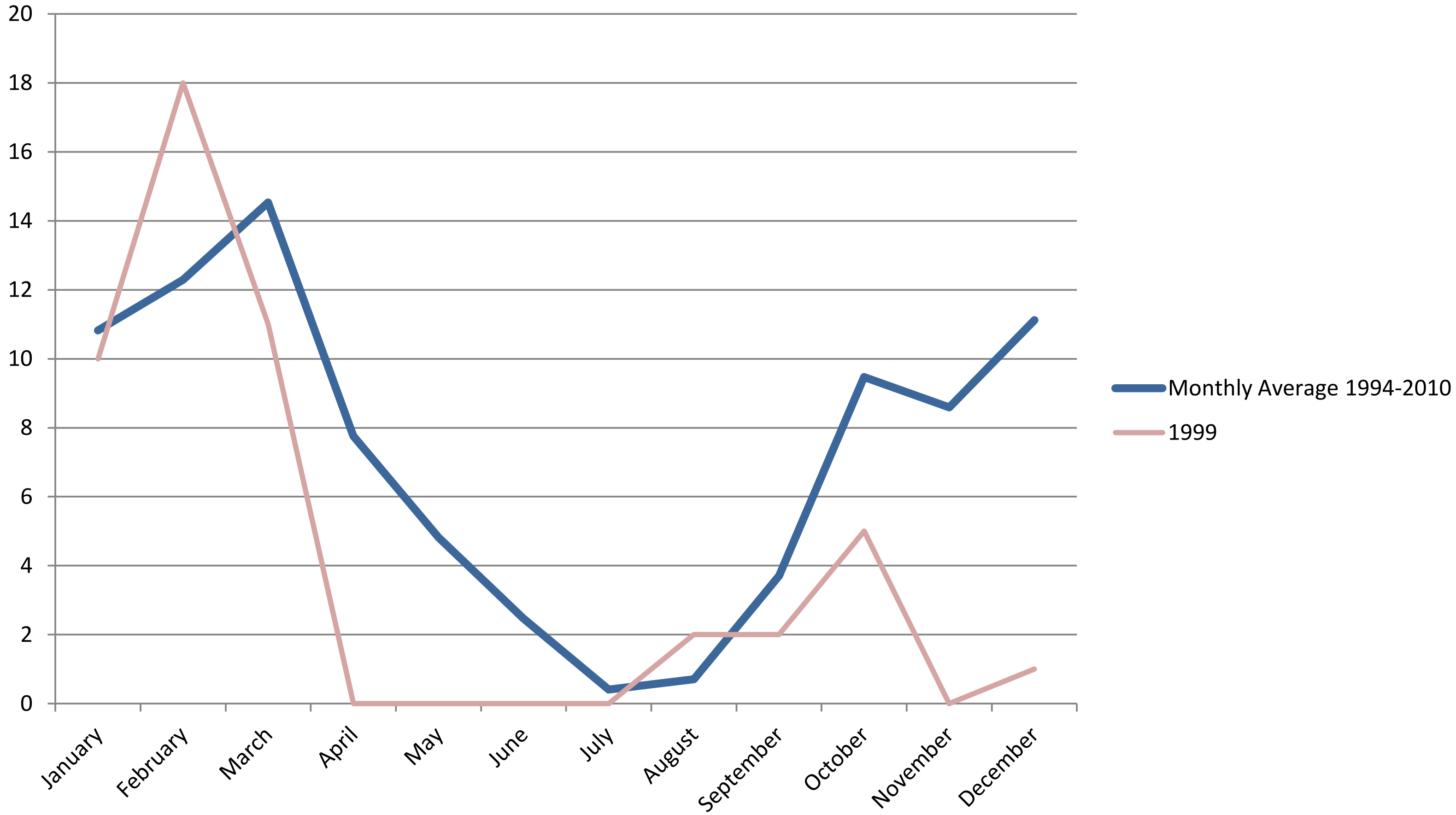
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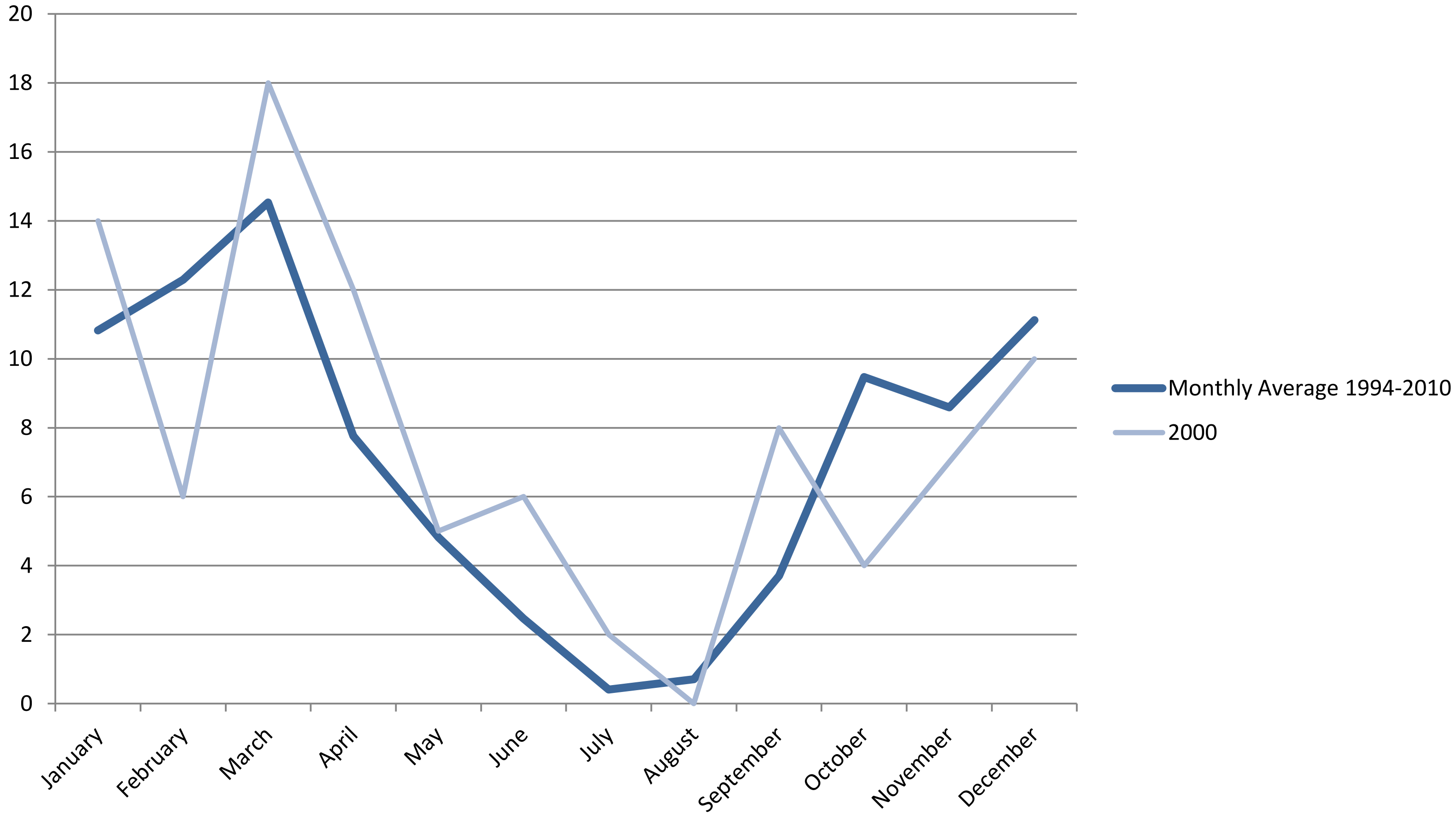
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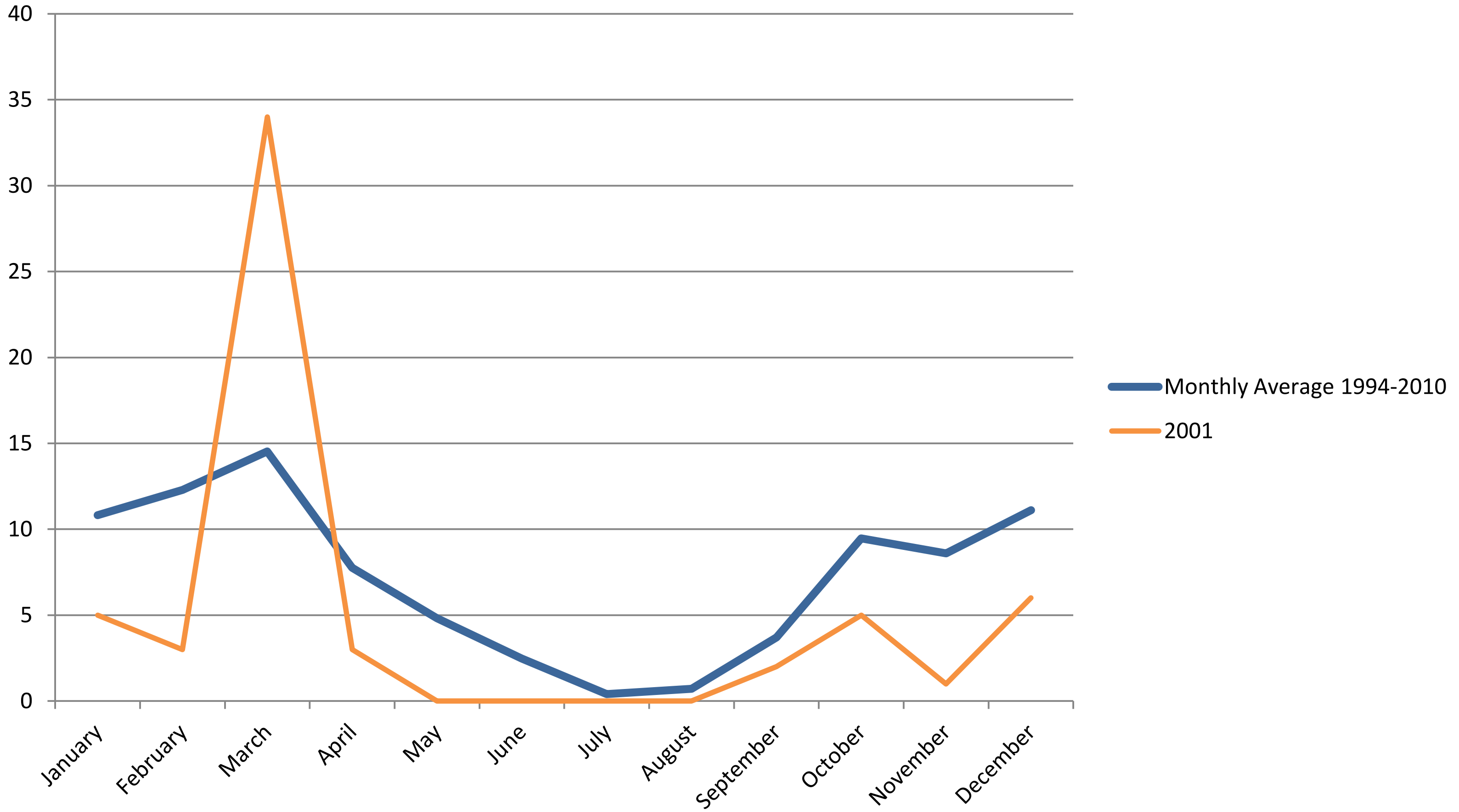

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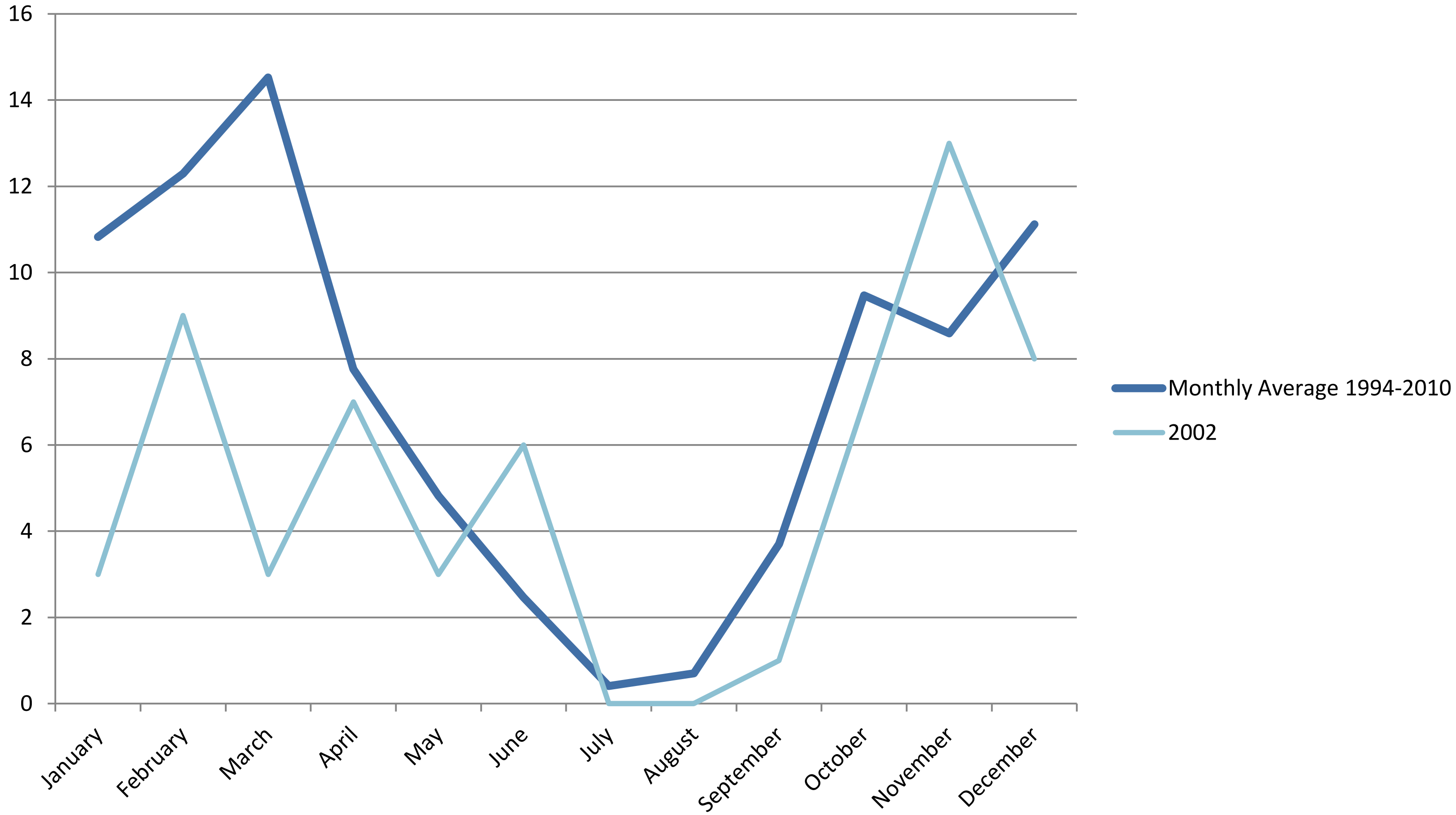
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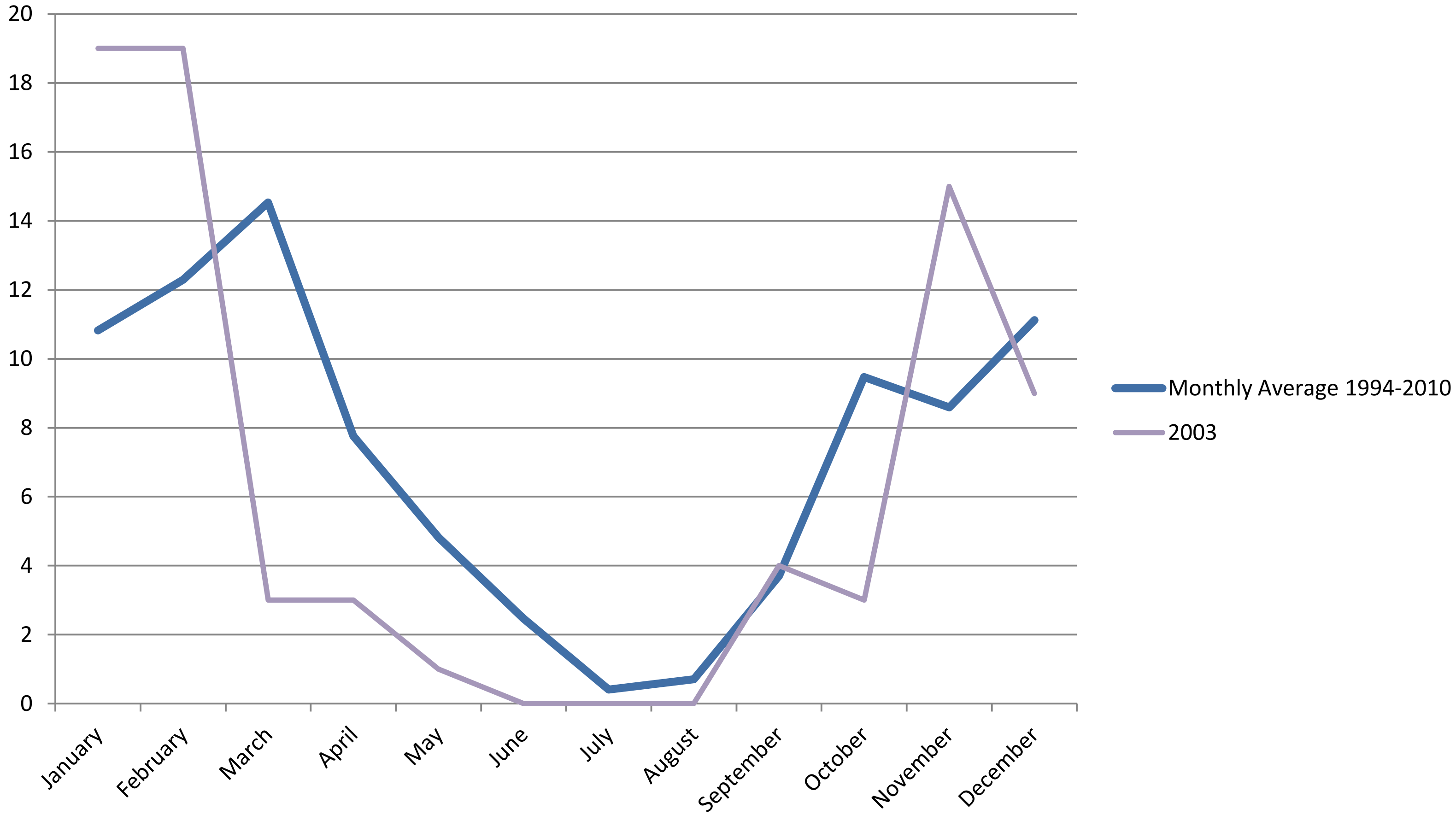
Monthly Average 1994-2010
2002



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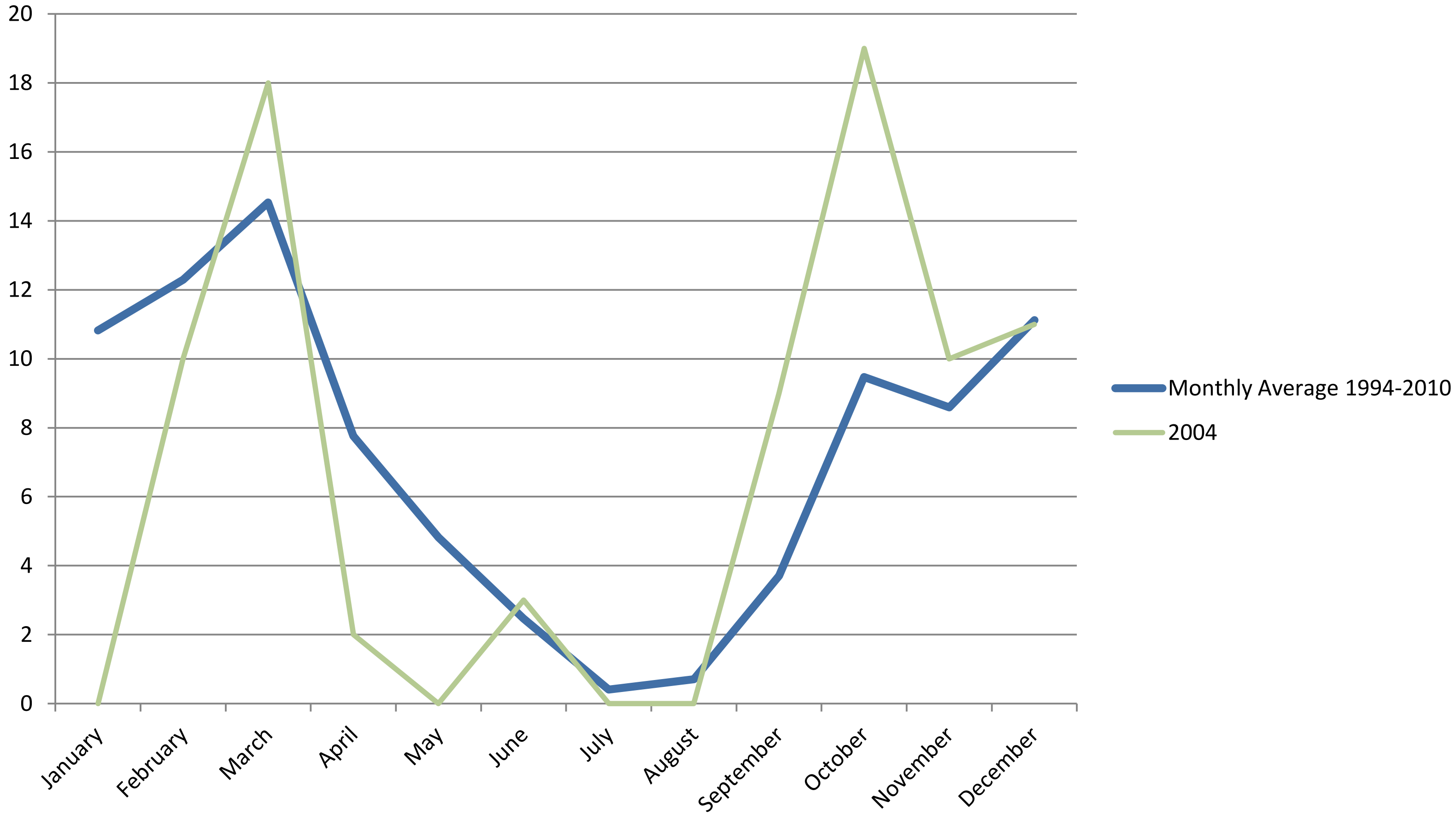

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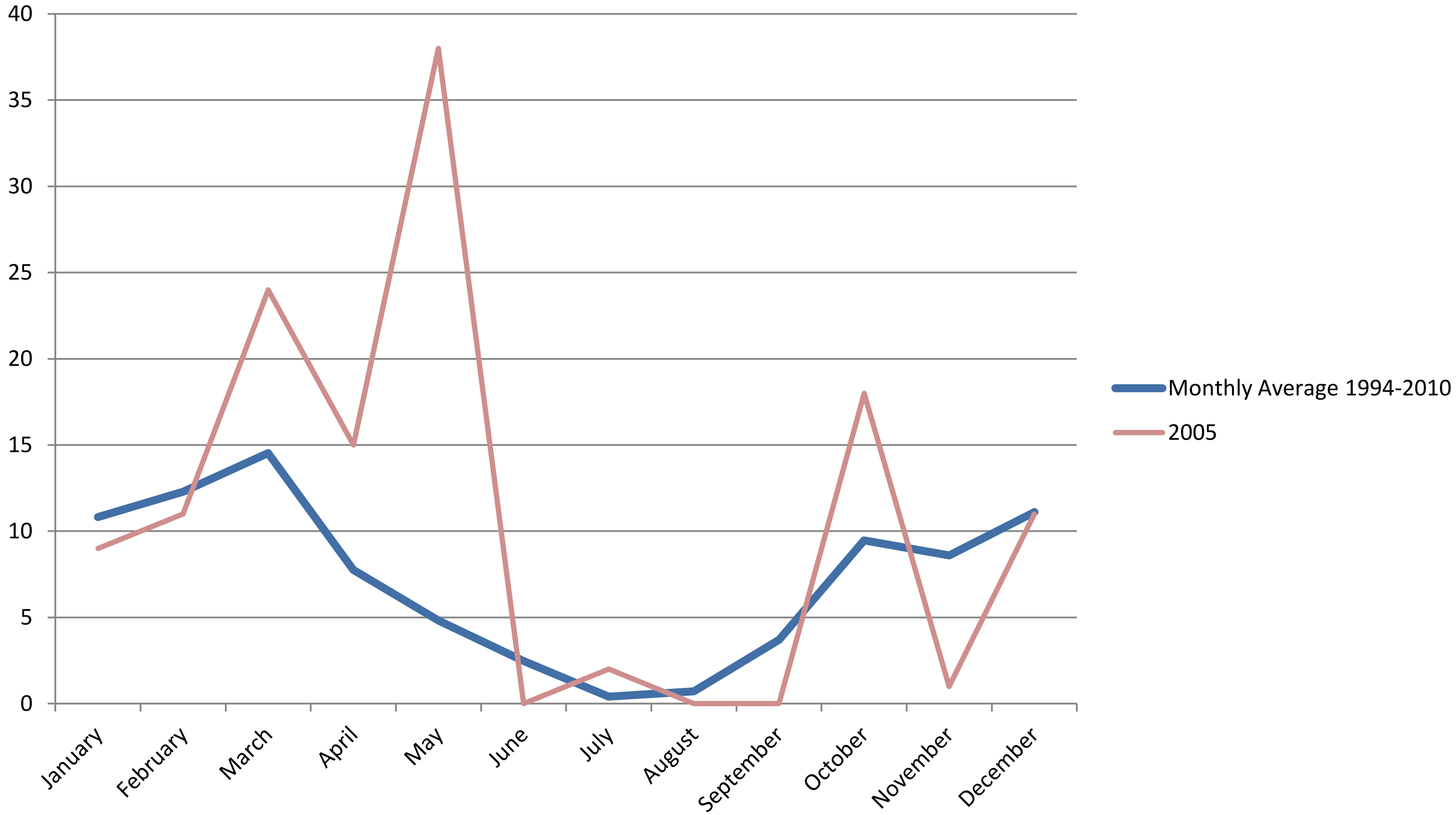

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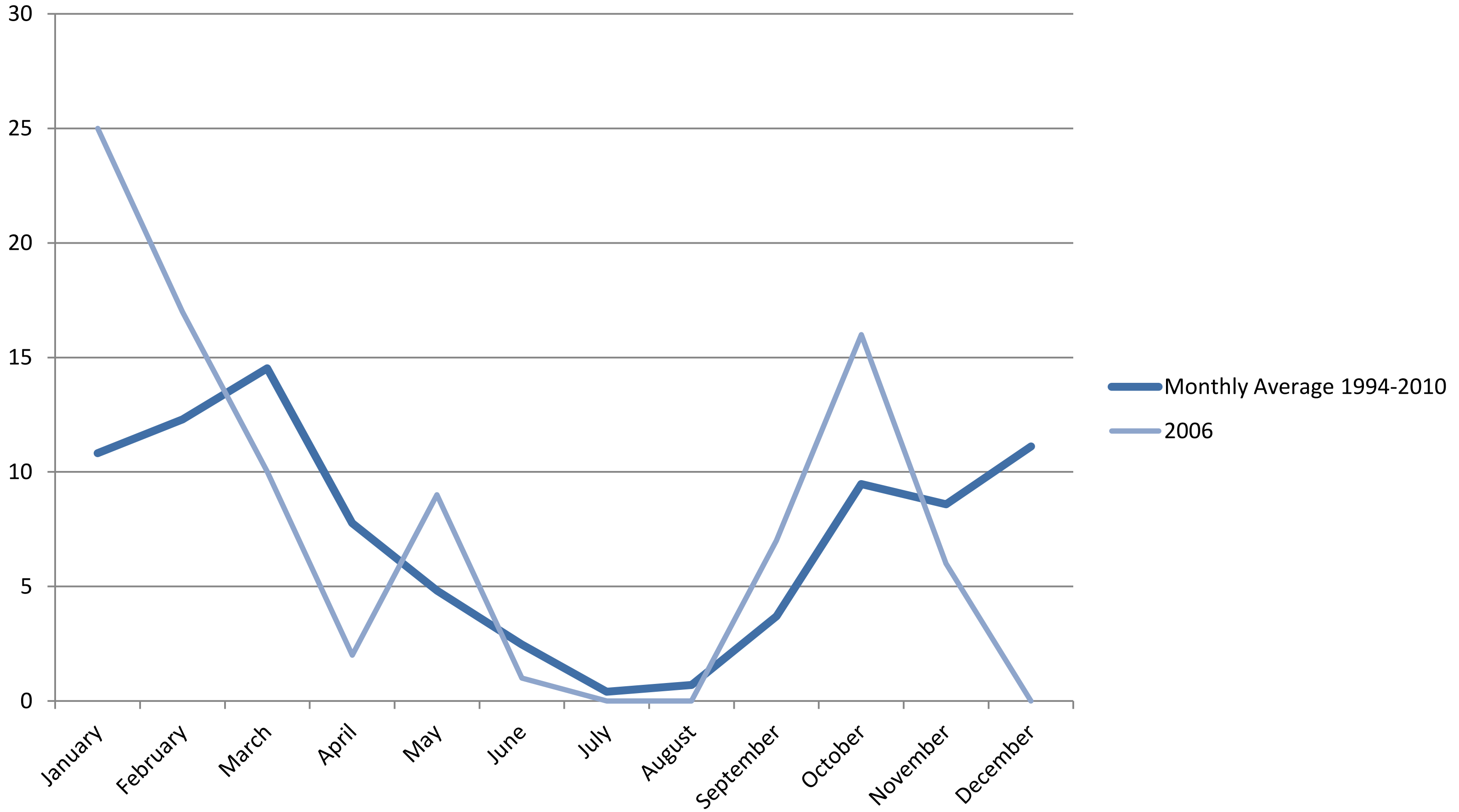

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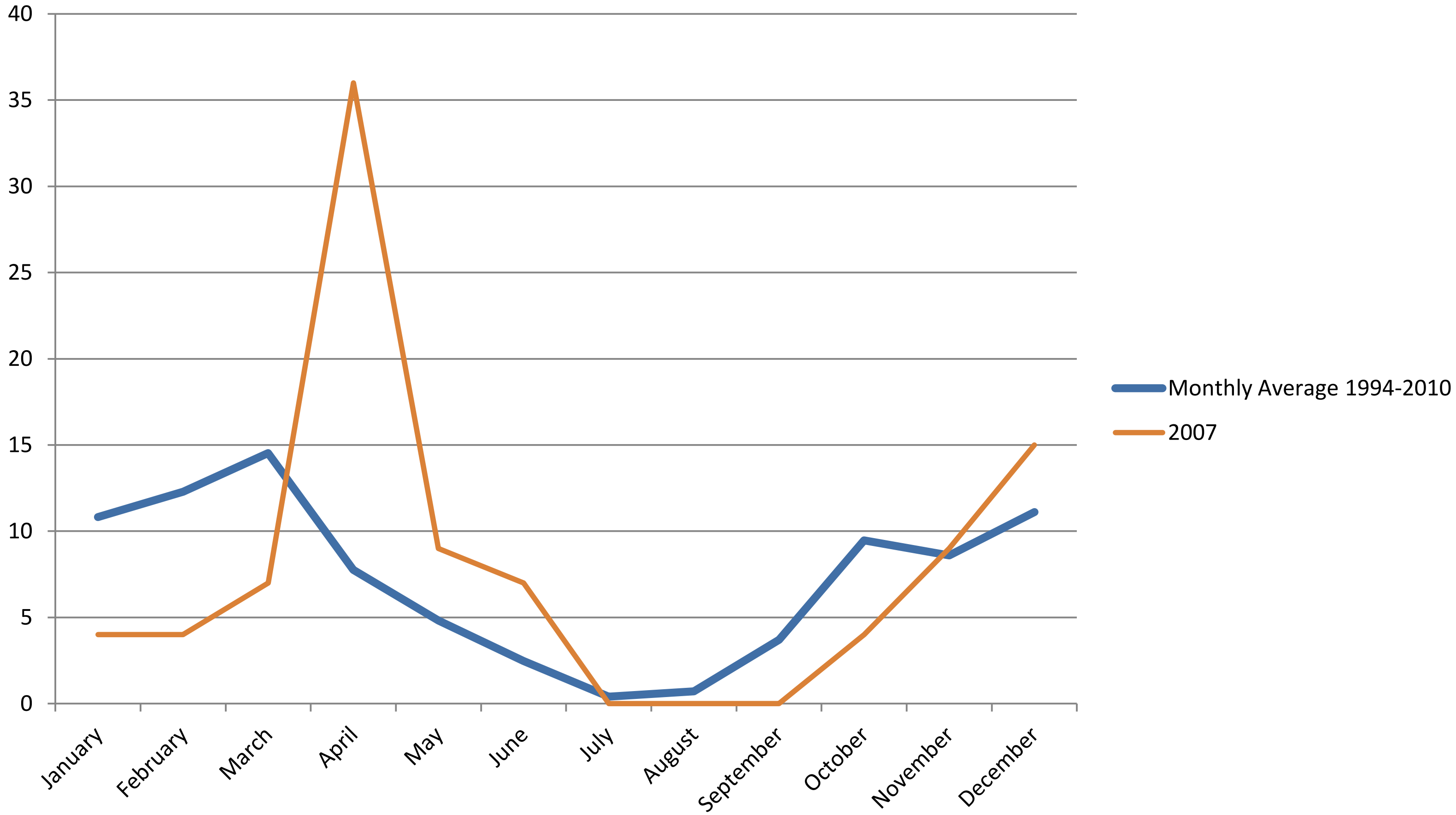

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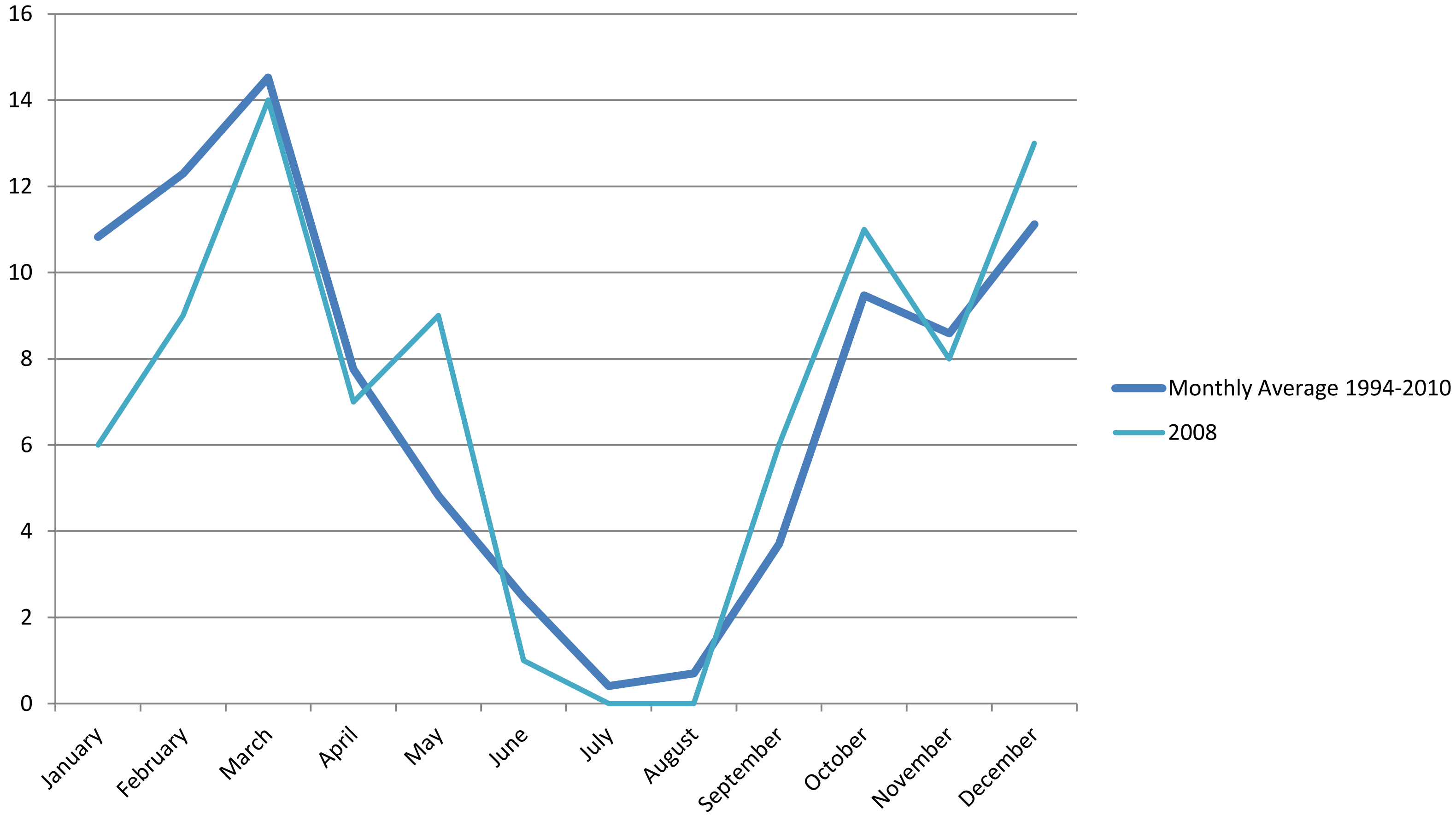
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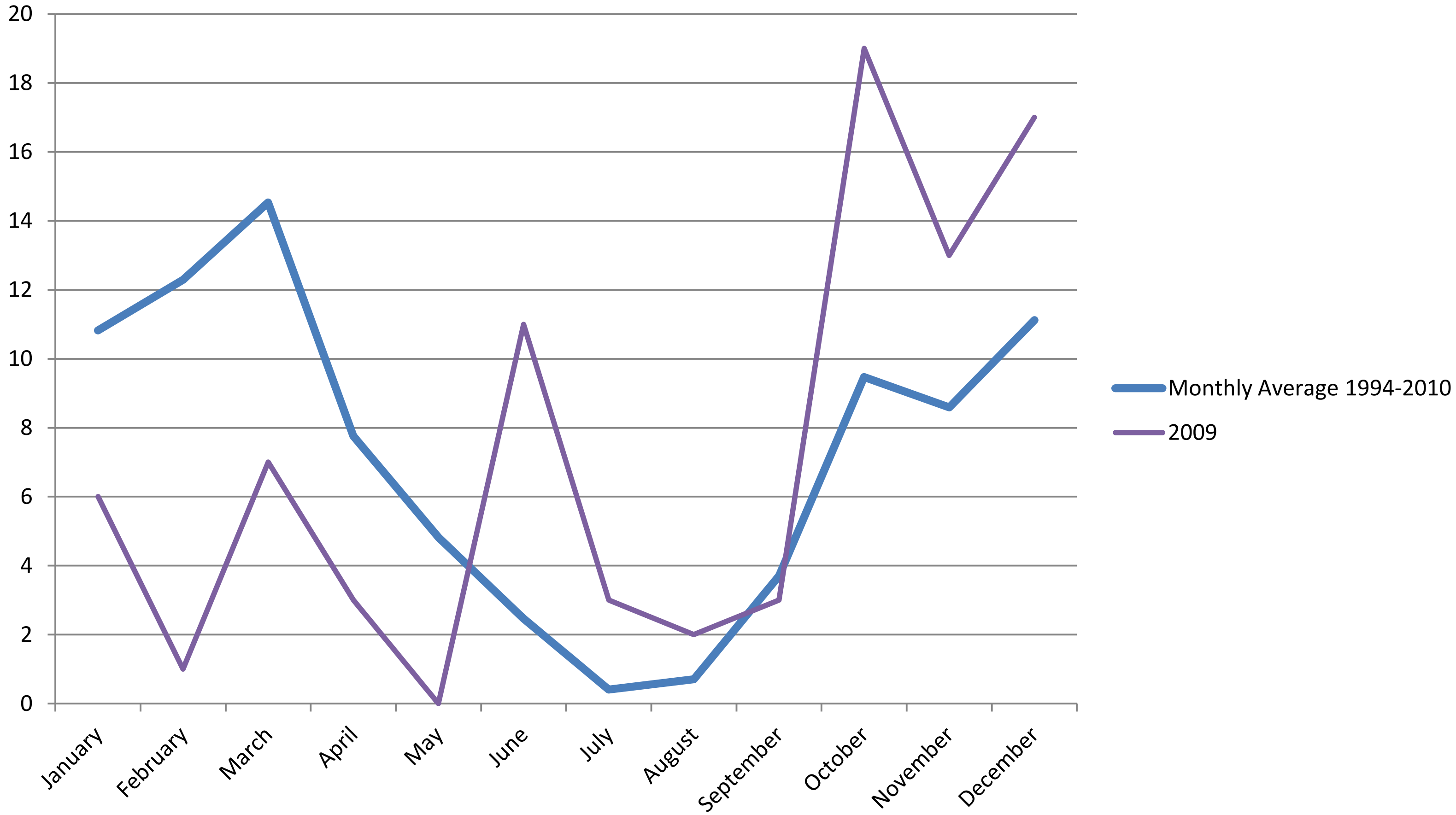
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Monthly Average 1994-2010
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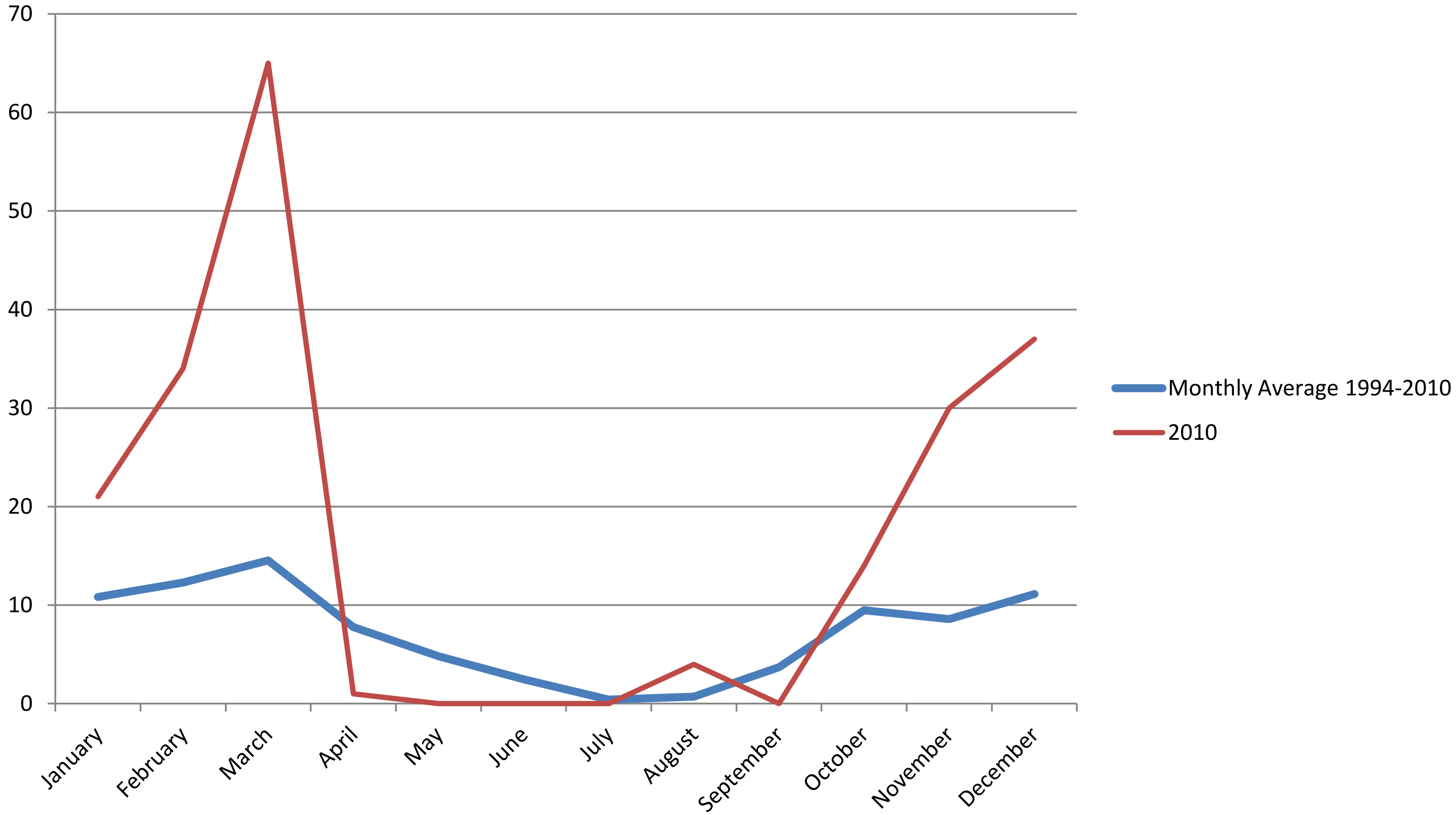

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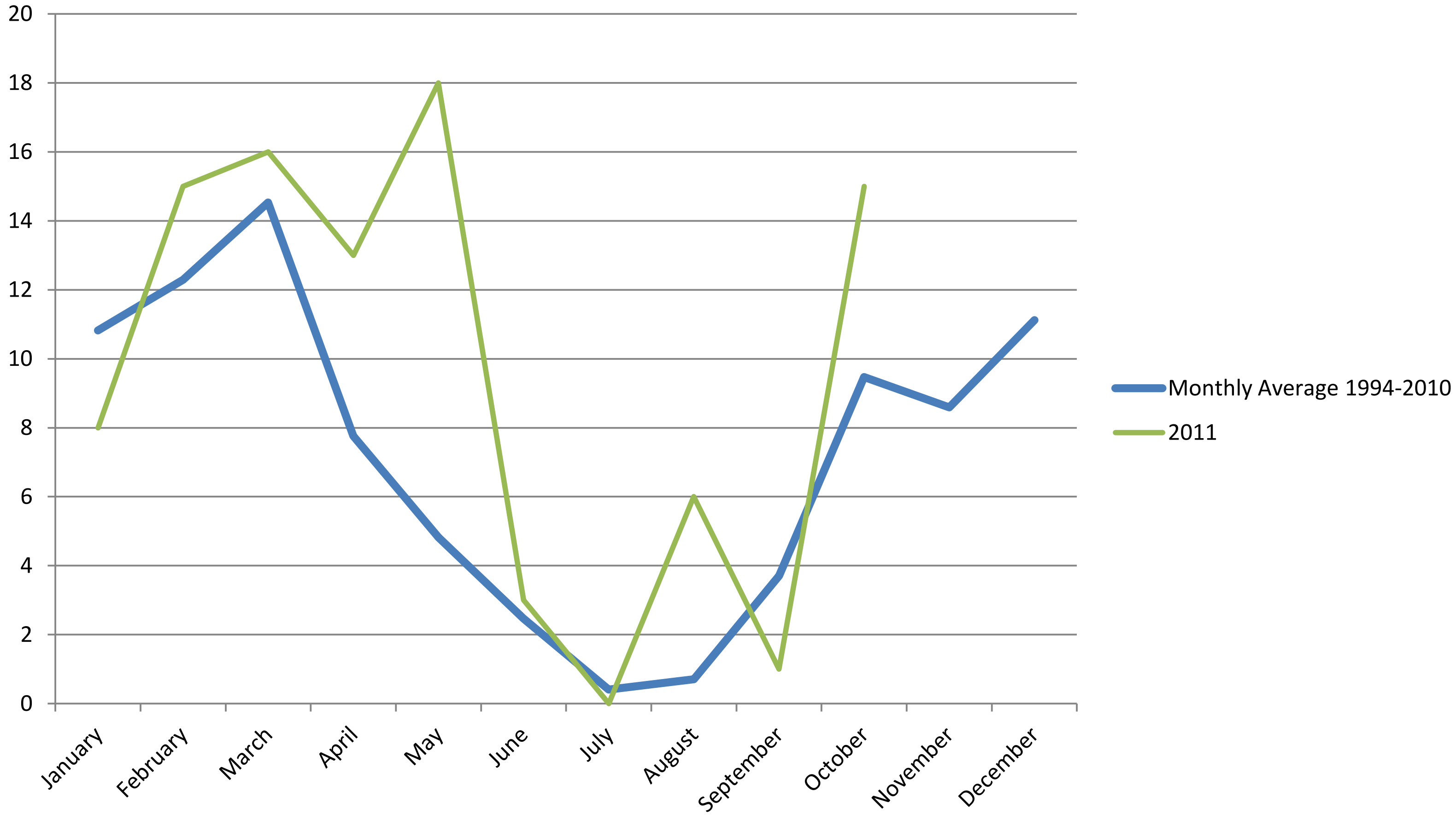
2010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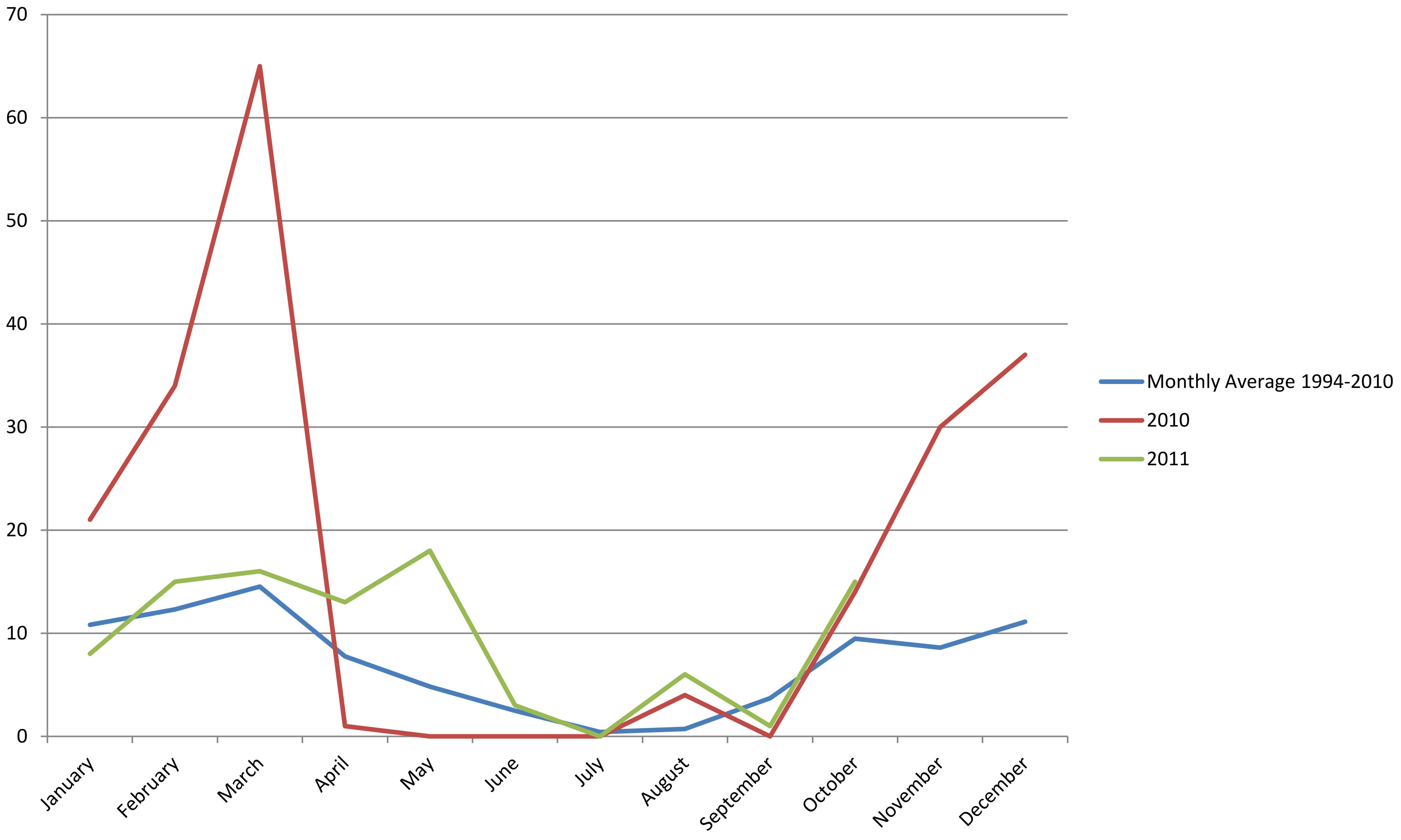
Monthly Average 1994-2010
2011



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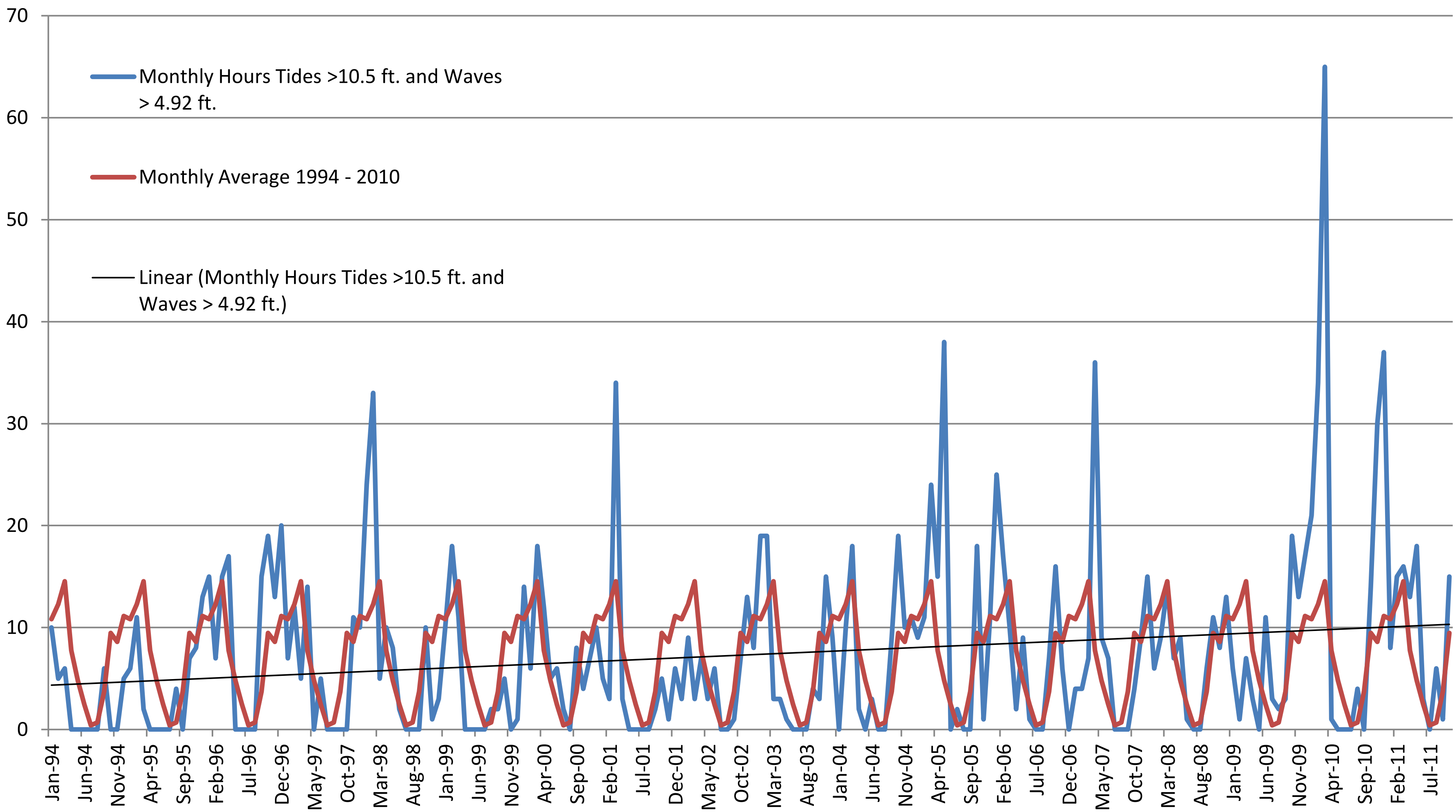
Monthly Average 1994-2010
2010
2011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Monthly Hours Tides >10.5 ft. and Waves > 4.92 ft.
Monthly Average 1994 - 2010
Linear (Monthly Hours Tides >10.5 ft. and Waves > 4.92 ft.)
Jan-94
Jun-94
Nov-94
Apr-95
Sep-95
Feb-96
Jul-96
Dec-96
May-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
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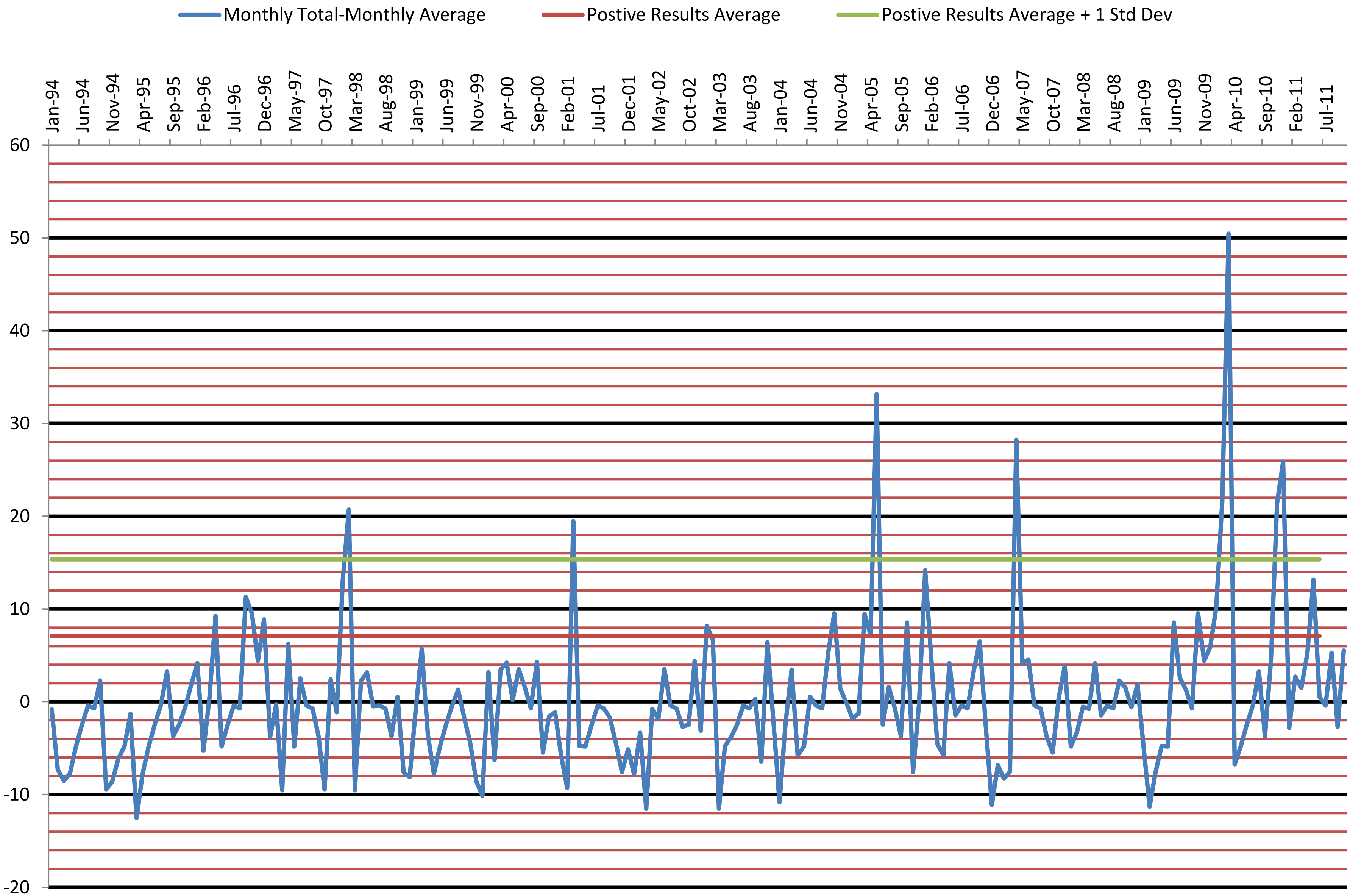
Jul-11


Monthly Total-Monthly Average
Postive Results Average
Postive Results Average + 1 Std Dev
Jan-94
Jun-94
Nov-94
Apr-95
Sep-95
Feb-96
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May-97
Oct-97
Mar-98
Aug-98
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Apr-10
Sep-10
Feb-11
Jul-11
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-10
-20

	Tide>10.5	Wave>4.92	Tide>10.5&Wave>4.92	Avg	Avg + StdDev	Total -Avg	Avg of + numbers	Avg of + numbers +StdDev
Mar-10	87	349	65	14.53	15.54	50.47	7.06	15.35
May-05	57	201	38	4.824	9.322	33.176	7.06	15.35
Apr-07	43	214	36	7.765	9.216	28.235	7.06	15.35
Dec-10	65	296	37	11.12	8.58	25.88	7.06	15.35
Feb-10	56	209	34	12.29	9.465	21.71	7.06	15.35
Nov-10	46	292	30	8.588	7.484	21.412	7.06	15.35
Feb-98	55	275	33	12.29	9.465	20.71	7.06	15.35
Mar-01	44	231	34	14.53	15.54	19.47	7.06	15.35
Jan-06	43	203	25	10.82	7.585	14.18	7.06	15.35
Jan-98	42	296	24	10.82	7.585	13.18	7.06	15.35
May-11	48	171	18	4.824	9.322	13.176	7.06	15.35
Sep-96	61	122	15	3.706	4.269	11.294	7.06	15.35
Jan-10	52	214	21	10.82	7.585	10.18	7.06	15.35
Oct-96	45	137	19	9.471	6.82	9.529	7.06	15.35
Oct-04	47	271	19	9.471	6.82	9.529	7.06	15.35
Oct-09	40	170	19	9.471	6.82	9.529	7.06	15.35
Mar-05	41	235	24	14.53	15.54	9.47	7.06	15.35
Apr-96	35	134	17	7.765	9.216	9.235	7.06	15.35
Dec-96	39	180	20	11.12	8.58	8.88	7.06	15.35
Oct-05	31	259	18	9.471	6.82	8.529	7.06	15.35
Jun-09	59	58	11	2.471	3.338	8.529	7.06	15.35
Jan-03	31	176	19	10.82	7.585	8.18	7.06	15.35
Apr-05	47	142	15	7.765	9.216	7.235	7.06	15.35
Feb-03	22	162	19	12.29	9.465	6.71	7.06	15.35
Oct-06	38	158	16	9.471	6.82	6.529	7.06	15.35
Nov-03	31	165	15	8.588	7.484	6.412	7.06	15.35
Apr-97	50	174	14	7.765	9.216	6.235	7.06	15.35
Dec-09	36	288	17	11.12	8.58	5.88	7.06	15.35
Feb-99	34	197	18	12.29	9.465	5.71	7.06	15.35
Oct-11	55	110	15	9.471	6.82	5.529	7.06	15.35
Sep-04	27	89	9	3.706	4.269	5.294	7.06	15.35
Aug-11	60	33	6	0.706	1.404	5.294	7.06	15.35
Apr-11	33	105	13	7.765	9.216	5.235	7.06	15.35
Feb-06	35	133	17	12.29	9.465	4.71	7.06	15.35
Jun-07	32	72	7	2.471	3.338	4.529	7.06	15.35
Oct-10	43	137	14	9.471	6.82	4.529	7.06	15.35
Nov-96	38	166	13	8.588	7.484	4.412	7.06	15.35
Nov-02	33	178	13	8.588	7.484	4.412	7.06	15.35
Nov-09	27	263	13	8.588	7.484	4.412	7.06	15.35
Sep-00	26	54	8	3.706	4.269	4.294	7.06	15.35
Apr-00	25	200	12	7.765	9.216	4.235	7.06	15.35
Jan-96	37	222	15	10.82	7.585	4.18	7.06	15.35
May-06	34	176	9	4.824	9.322	4.176	7.06	15.35

Massachusetts Shoreline Change Project - Windows Internet Explorer provided by Yahoo!

http://www.mass.gov/czm/hazards/shoreline_change/shorelinechangeproject.htm

Massachusetts Office of

COASTAL ZONE MANAGEMENT

Massachusetts Shoreline Change Project

To help make informed and responsible decisions, coastal managers, shorefront landowners, and potential property buyers need information on both current and historical shoreline trends, including reliable measurements of erosion and accretion rates in non-stable areas. The goal of the Massachusetts Office of Coastal Zone Management (CZM) Shoreline Change Project is to develop and distribute scientific data that will help inform local land use decisions.

CZM's Shoreline Change Project illustrates how the shoreline of Massachusetts has shifted between the mid-1800s and 1994. Five relative high water lines and change rates at 40-meter intervals along the ocean-facing shore have been determined using data from historical and modern sources. CZM has incorporated these shoreline change data into MORIS, the Massachusetts Ocean Resource Information System, which can be readily accessed by the public.

View the Shoreline Change Map: Please proceed to the Shoreline Change Fact Sheet, which explains the use and limitations of this project and leads to an online map with available shorelines, transects, and rates of change.

Shoreline Change Map

Search

Search CZM go!

Coastal Shoreline and Floodplain Management Home

COASTAL ZONE MANAGEMENT
251 Causeway Street, Suite 800 • Boston, MA 02114
617-626-1200 • 617-626-1240 (fax)
czm@state.ma.us

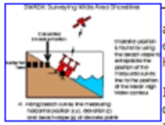
SWASH: a New Method for Quantifying Coastal Change

Introduction

Coastal erosion is a serious national problem with long-term economic and social consequences. Developed areas are threatened with billions of dollars in property damage as a result of storm impacts and long-term erosion. Over the last few decades, data on the position of the shoreline has emerged as the principal source of information for local, state, and federal government agencies charged with managing coastal erosion. This measure of the shifting land/water interface is also an important source of information for scientific investigations of coastal change, for determinations of the sediment budget, and for conducting numerical simulations of shoreline change.

Despite the importance of this measure of coastal change, the methods available for collecting shoreline position data are very limited. The most commonly applied method-shoreline interpretation from aerial photography-is expensive, labor-intensive, and involves a considerable amount of subjectivity in identifying the shoreline. There is a significant need for a method that can provide an unambiguous and repeatable measure of shoreline position, can cover large sections of coast within a single low tide period, is inexpensive to operate, and can be used for both long-term monitoring and rapid-response surveys of storm impacts. In response to this need, theUSGSdevelopedSWASH, a vehicle-based system for measuring shoreline position which utilizes recent advances in the Global Positioning System (GPS).SWASHstands for "Surveying Wide-Area Shorelines."

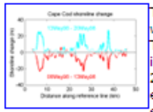
Methodology



TheSWASHsystem is mounted on a six-wheel amphibious all-terrain vehicle (click here for image of the buggy and details of instruments used). As the vehicle transits the coast, an array of GPS sensors are used to make high-accuracy measurements of horizontal position, vertical position, and beach slope. Following the field survey, position and slope data are combined to compute shoreline position, defined as the horizontal location of a target elevation contour's intersection with the beach. See SWASHschematic for more details. In keeping with historical sources on shoreline information, the Mean High Water (MHW) contour is usually chosen as the definition of the shoreline.

In contrast to shorelines derived by most previous methods,SWASHshorelines have well-defined error bars, important for determining the statistical significance of shoreline change. Error bars are calculated on a point-by-point basis as a function of beach slope and the deviation between the elevation driven and MHW.SWASHcan survey more than 70 km of shoreline within a single low tide period and provide near real-time information on shoreline changes during storms.SWASHis also very inexpensive to operate relative to previous methods for obtaining shoreline position.

Current Survey Program and Example Results

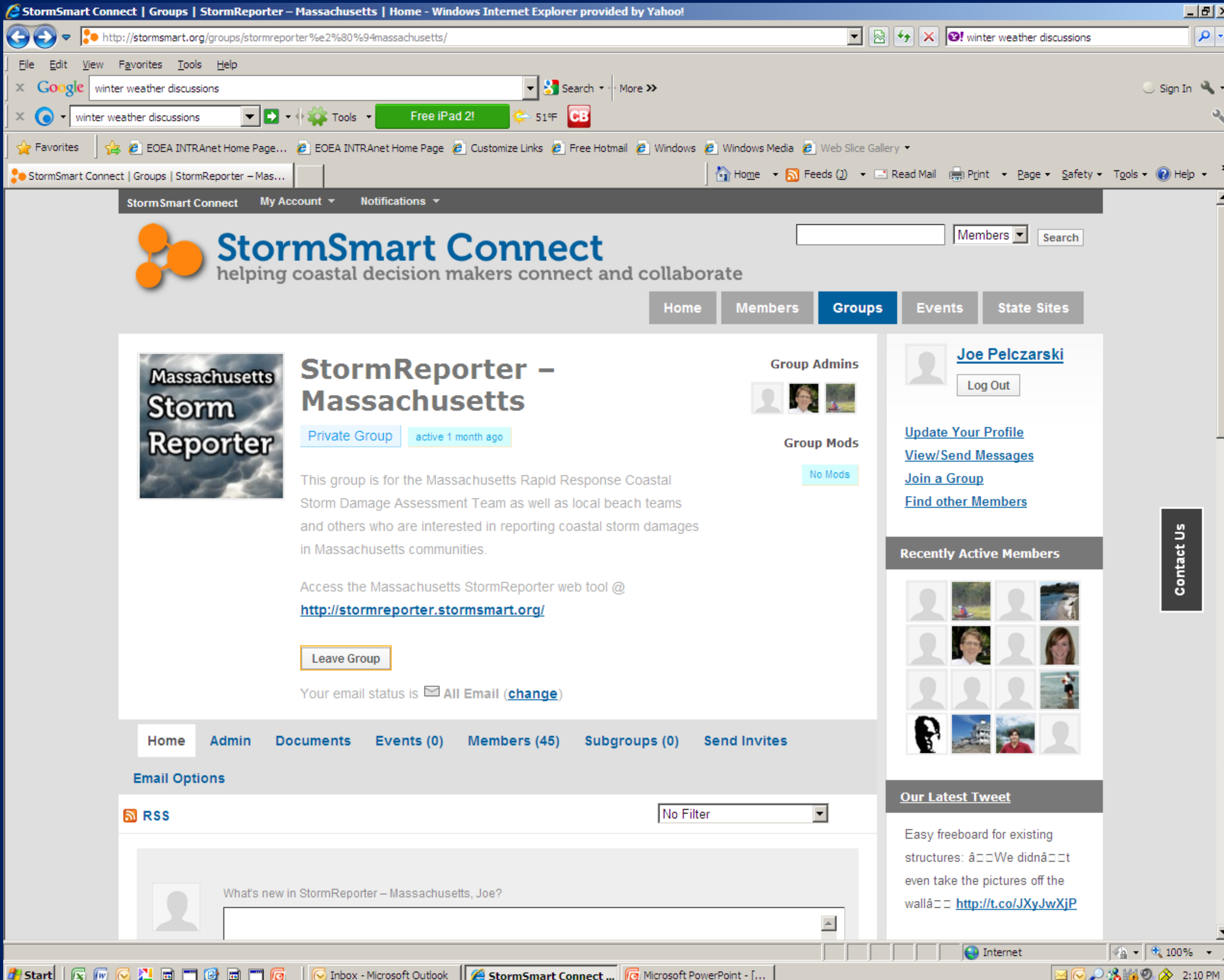


TheSWASHsystem is currently being applied to study storm-induced and fair weather shoreline change on beaches in North Carolina and Massachusetts. The most extensive set of measurements are within the Cape Cod National Seashore, where both the short-term impact of storms and the longer seasonal cycle of change has been measured in a continuing survey program initiated in April 1998. This study area map shows the along-coast reference line used in the following example results. An example of the short-term impact of a Northeaster storm on 45 km of Cape Cod's outer coast is given in this figure. The shoreline erosion response was extraordinarily non-uniform, with zones of significant erosion (more than 20 m of shoreline recession) alternating with zones of virtual stability (less than 2 m of change). In the period of decreasing waves following the storm, the pattern of change almost entirely reversed, with the erosional zones showing strong accretion and the stable zones still exhibiting no significant change. Similar results have been obtained for other storms on Cape Cod, as well as along the Outer Banks of North Carolina. Although the processes responsible for these erosional "hotspots" are unknown, their identification has important implications for management of both cultural and environmental resources along the coast. Research is ongoing to better characterize the locations and persistence of erosional hotspots and to understand their cause or causes.

The seasonal cycle of shoreline position variability on Cape Cod is given in this figure. Shoreline position is averaged over the "bluff-backed coast" (kilometers 17.5 to 45.0 on the Cape Cod study area map) and plotted as a function of time since the first survey in April 1998. Although much variability exists from survey to survey, there is a clear yearly signal of erosion and accretion which is tied to variations in overall storminess between winter and summer. This data series, when extended for several more years, will help characterize the natural high-frequency variability of shoreline position, both in winter and summer, information important for quantifying the error in estimates of long-term shoreline change.

For discussion, comments, or questions on the SWASH system contact: Jeff List (jlist@usgs.gov) or

Jeffrey H. List | jlist@usgs.gov
U.S. Geological Survey | PH: (508) 457-2343
384 Woods Hole Road | FAX: (508) 457-2310
Woods Hole, MA 02543-1598 |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helping coastal decision makers connect and collaborate
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Events
State Sites
Massachusetts Storm Reporter
StormReporter – Massachusetts
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active 1 month ago
Group Admins
Group Mods
No Mods
This group is for the Massachusetts Rapid Response Coastal Storm Damage Assessment Team as well as local beach teams and others who are interested in reporting coastal storm damages in Massachusetts communities.
Access the Massachusetts StormReporter web tool @ http://stormreporter.stormsmart.org/
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Home
Admin
Documents
Events (0)
Members (45)
Subgroups (0)
Send Invites
Email Options
RSS
No Filter
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Easy freeboard for existing structures: â□□We didnâ□□t even take the pictures off the wallâ□□ http://t.co/JXyJwXjP
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COASTAL STORM DAMAGE DATA SHEETS

Signed in as **Joe Pelczarski**.

Search: Reporter [ ] Search

City/Town	Date/Time	Reporter	Manage
Marblehead	10/30/2011 13:30	Jan Smith	Edit Delete
Marblehead	10/30/2011 07:30	Jan Smith	Edit Delete
Salisbury	10/30/2011 10:00	Michelle Rowden	Edit Delete
Salisbury	10/30/2011 09:26	Michelle Rowden	Edit Delete
Salisbury	10/30/2011 09:35	Michelle Rowden	Edit Delete
Rockport	10/30/2011 15:30	erichutchins	Edit Delete
Salisbury	10/30/2011 09:49	Michelle Rowden	Edit Delete
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Boston	10/30/2011 07:30	posidonia	Edit Delete
Plymouth	10/30/2011 09:45	Carlos T B Fragata	Edit Delete

Now Your Thoughts

Does

Big Waves + Higher Tides

=

a Storm Erosion Index

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