



UNIVERSITY OF SAN FRANCISCO  
CHANGE THE WORLD FROM HERE

# How Good People Make Bad Graphs

Unintentional Fibbing with Visualization

# INTRODUCTION



**Intentionally** lying  
with visualization is **easy**.



**Unintentionally** lying  
with visualization is **easy**.



How do **innocent** motivations  
lead to **misleading** visualizations?



Everyone **will** and **should** make  
a bad visualization at some point.

(You just might not want to SHARE it widely.)



# WARMEST YEARS

Climate Central, 2013



# HOW 2012 STACKS UP

THE WARMEST YEARS ON RECORD  
CONTIGUOUS U.S.



Source: NOAA's National Climatic Data Center - State of the Climate National Overview



<http://www.climatecentral.org/news/noaa-2012-was-warmest-and-second-most-extreme-year-on-record-15436>

<http://themonkeycage.org/blog/2013/01/08/how-2012-stacks-up-the-worst-graph-on-record/>



# Potential Issues

- Range on y-axis from  $53^{\circ}$  to  $55.5^{\circ}$ 
  - Bar charts should start at 0 on y-axis
  - Small ranges exaggerate small changes
- Sorting of values on x-axis by y-value
  - Unordered data can be sorted by y-value
  - Ordered data should be sorted by x-value



# Potential Issues

- Suggestive use of colors
  - Okay to use color to highlight data
  - Use of orange/red emphasizes warming
  - Intensity of foreground versus background similar
- Density could be improved slightly
  - Usually do not need data labels and axis lines
  - Accuracy to two decimal points on labels



# Potential Issues

- Unnecessary use of 2.5D/3D hinting
  - Skewed axis forces brain to account for distance bars are away from viewer
  - Shadow and shiny color gradients suggest 3D bars which encourages comparison by volume
  - Axis lines sit “behind” the bars, requiring some adjustment to match to bar heights



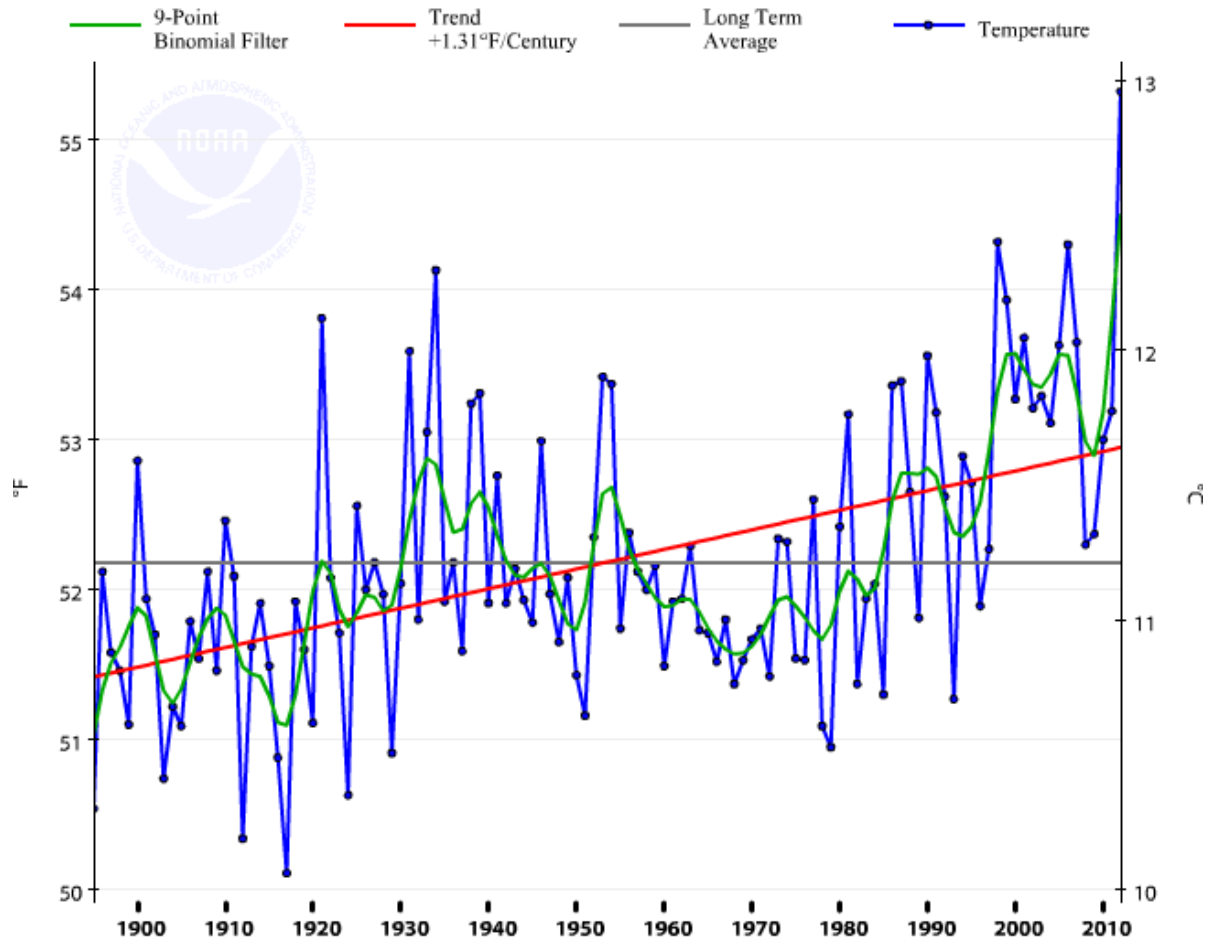
# How did this happen?

- Priority is to compare 2012 with other 5 hottest years
  - Removed context provided by other years and reordered x-axis to make comparison easier
- Wanted to emphasize change, even if small
  - Small changes in average temperature are considered a big deal
- Innocent design decisions to meet goals



# Contiguous U.S., Temperature, January-December

13



# HOW 2012 STACKS UP

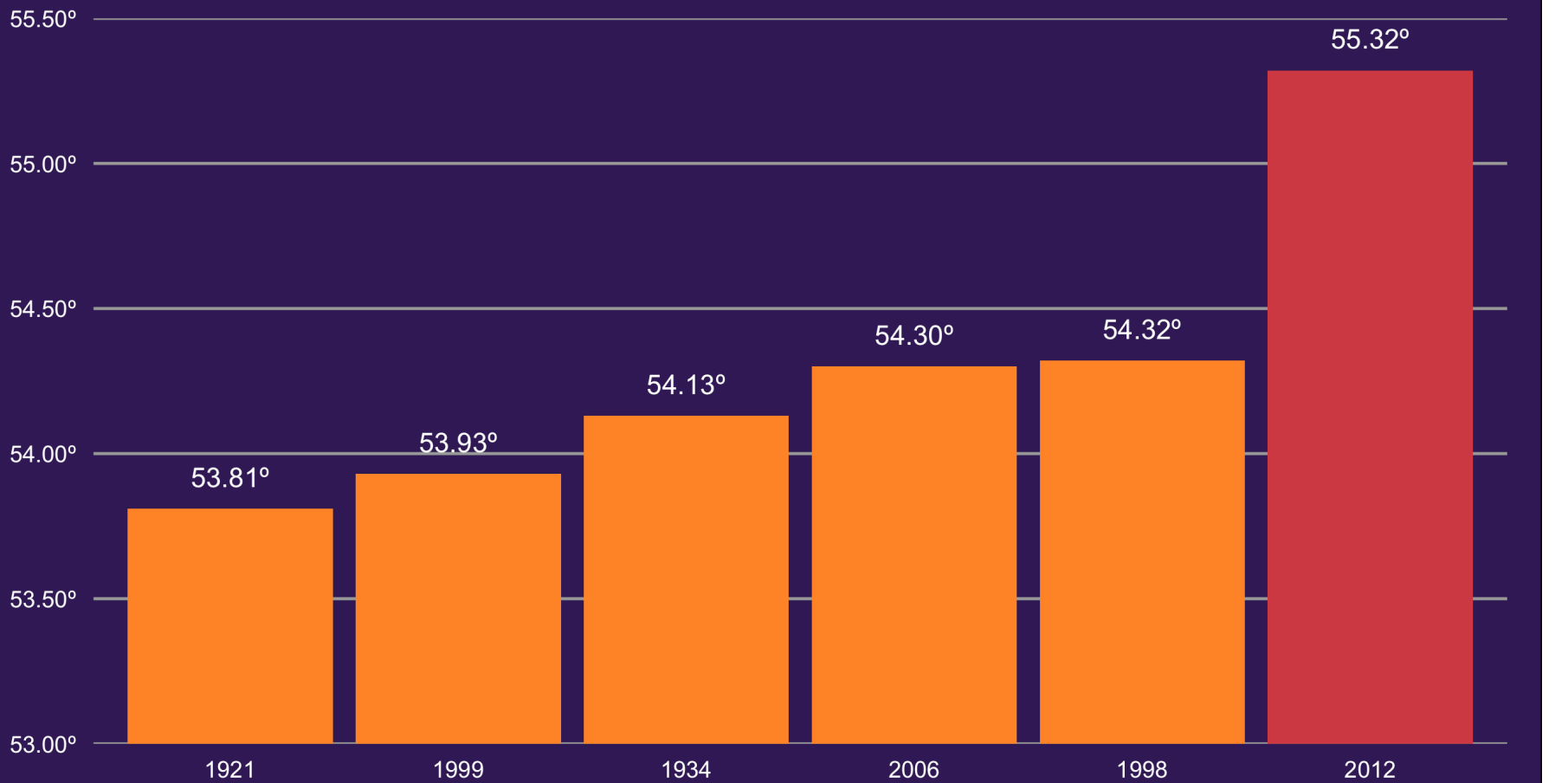
THE WARMEST YEARS ON RECORD  
CONTIGUOUS U.S.



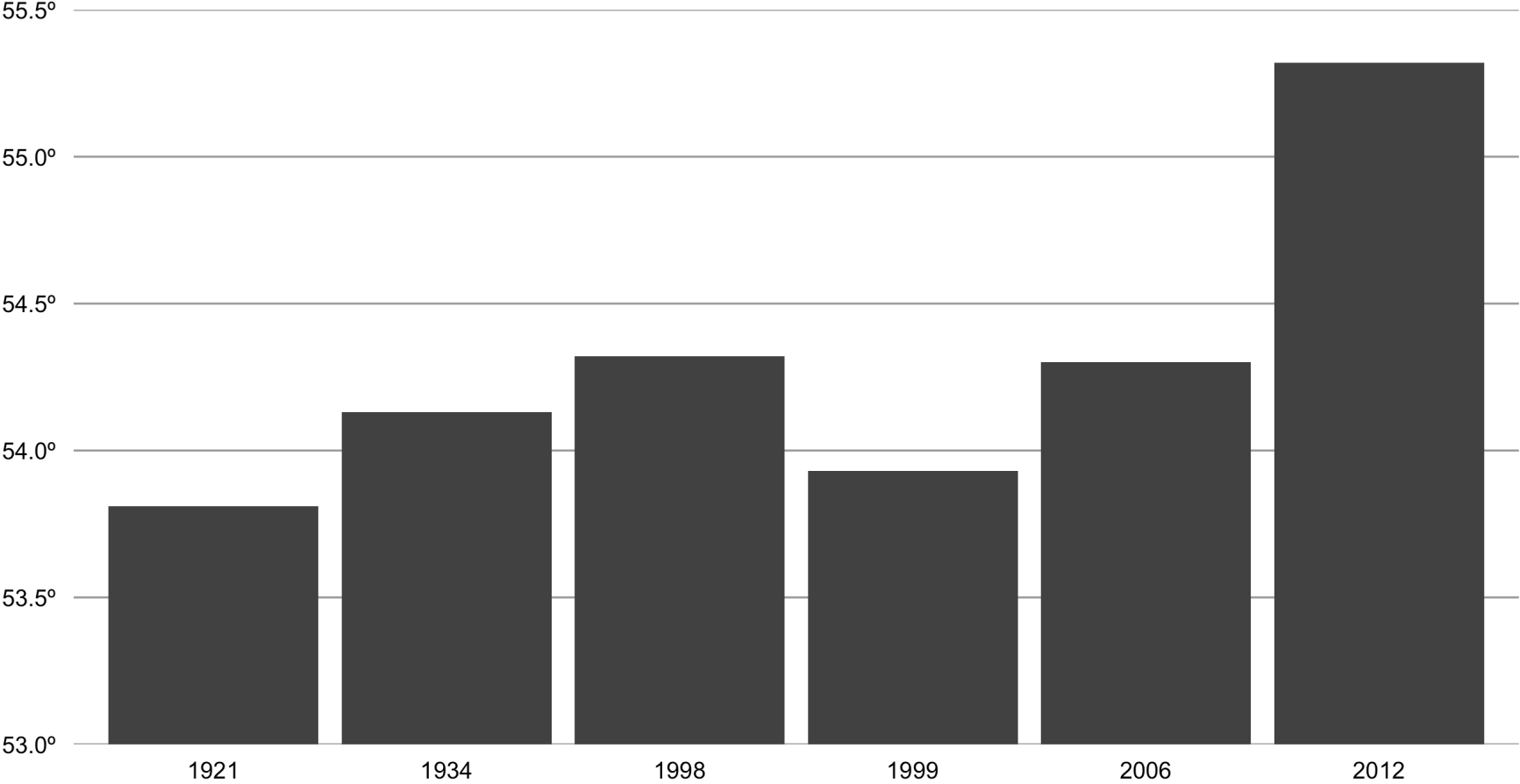
Source: NOAA's National Climatic Data Center - State of the Climate National Overview



## Warmest Years on Record (Contiguous US)



# Warmest Years on Record (Contiguous US)

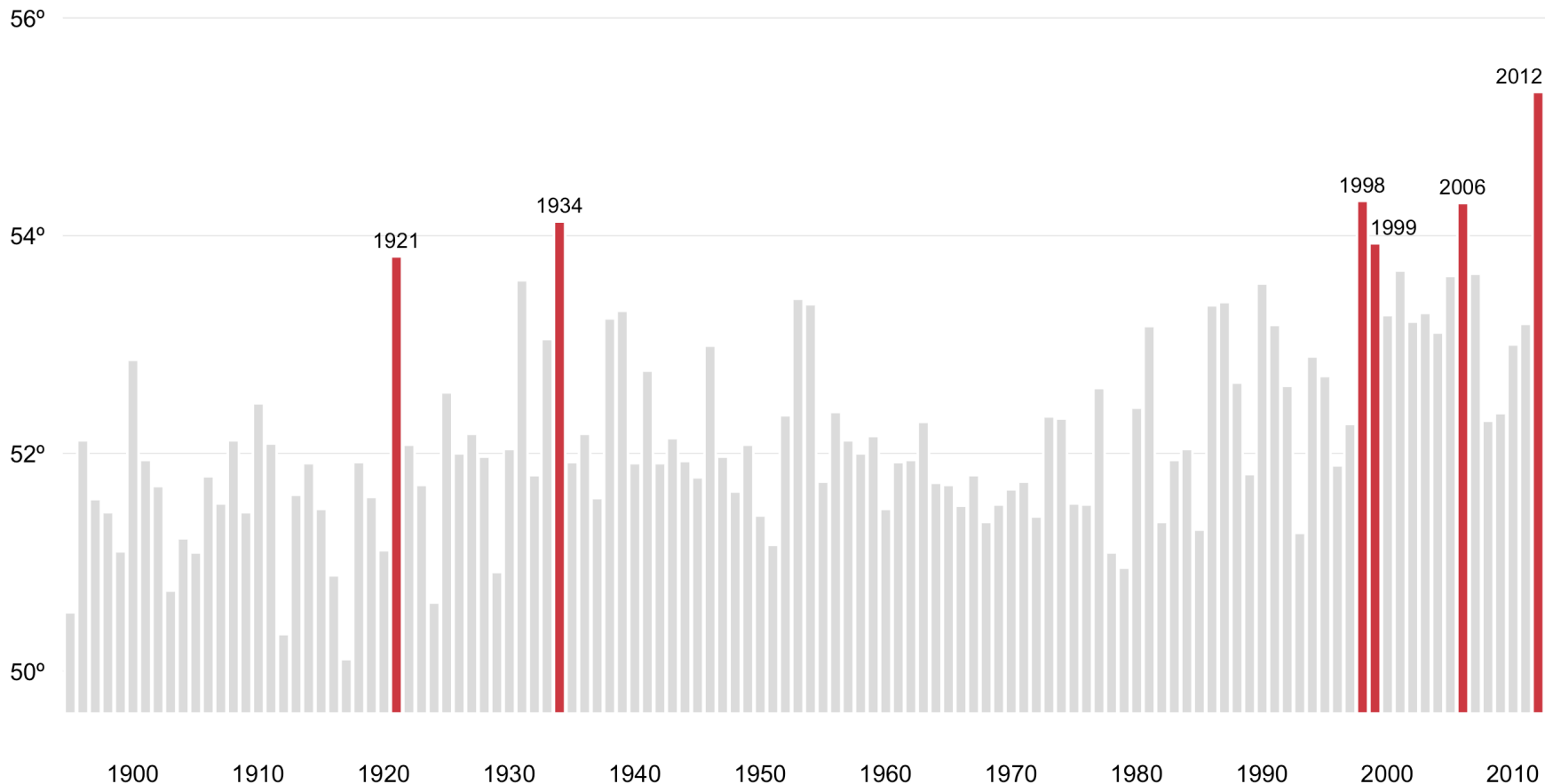


Removed sorting by temperature, unnecessary colors, and unnecessary text annotations.



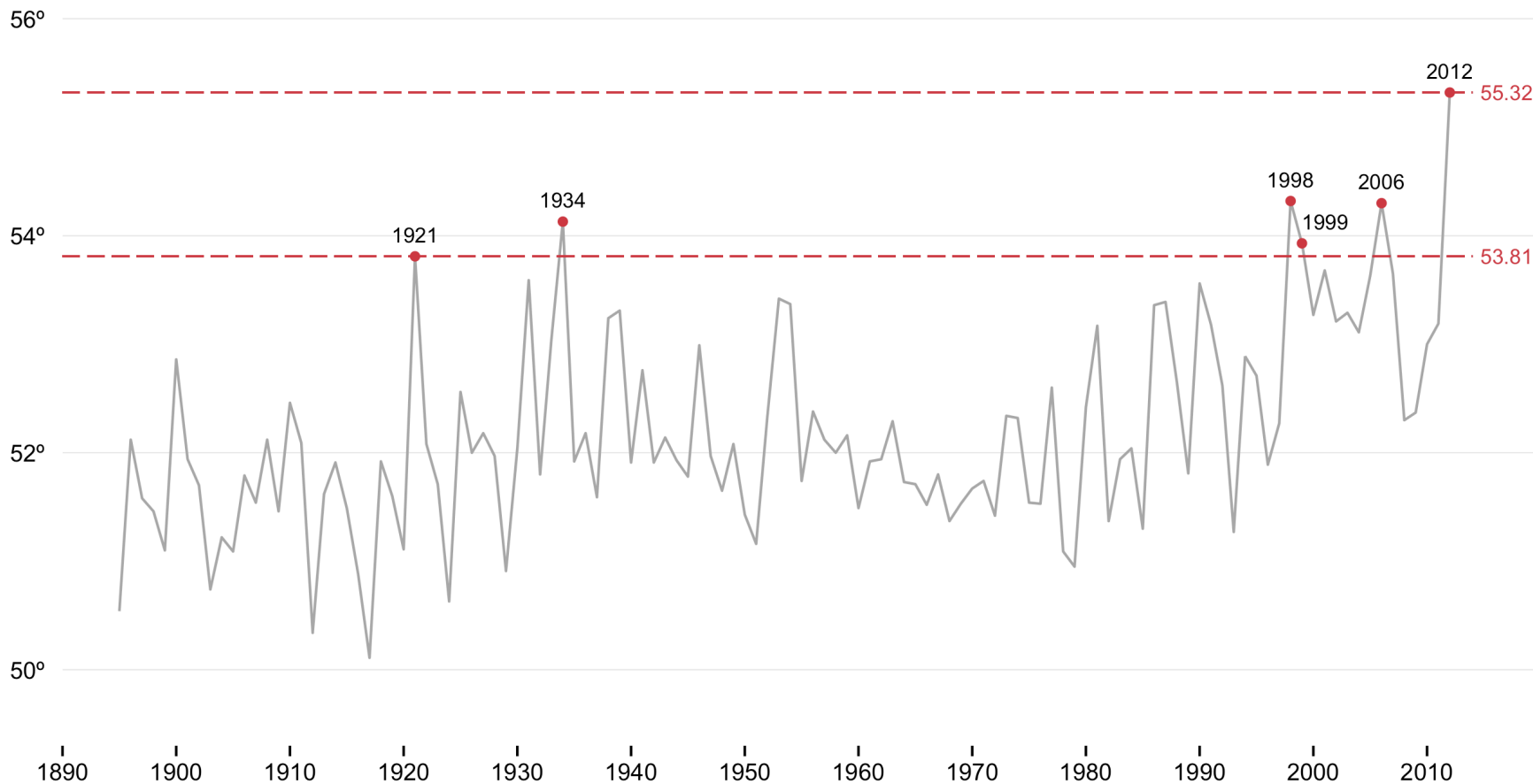
# Warmest Years on Record (Contiguous US)

17



Added in context of other years, while still focusing on warmest years. Still issues with bar plot not starting at 0.

## Warmest Years on Record (Contiguous US)



Changed from bar to line, which is more appropriate when not starting at 0. Added focus using annotations.

# GUN DEATHS IN FLORIDA

Business Insider, 2014



# Background

“A person who is not engaged in an unlawful activity and who is attacked in any other place where he or she has a right to be has no duty to retreat and has the right to **stand his or her ground** and meet force with force, including **deadly force** if he or she reasonably believes it is necessary to do so to prevent death or great bodily harm to himself or herself or another or to prevent the commission of a forcible felony.”

[http://www.leg.state.fl.us/statutes/index.cfm?App\\_mode=Display\\_Statute&URL=0700-0799/0776/Sections/0776.013.html](http://www.leg.state.fl.us/statutes/index.cfm?App_mode=Display_Statute&URL=0700-0799/0776/Sections/0776.013.html)



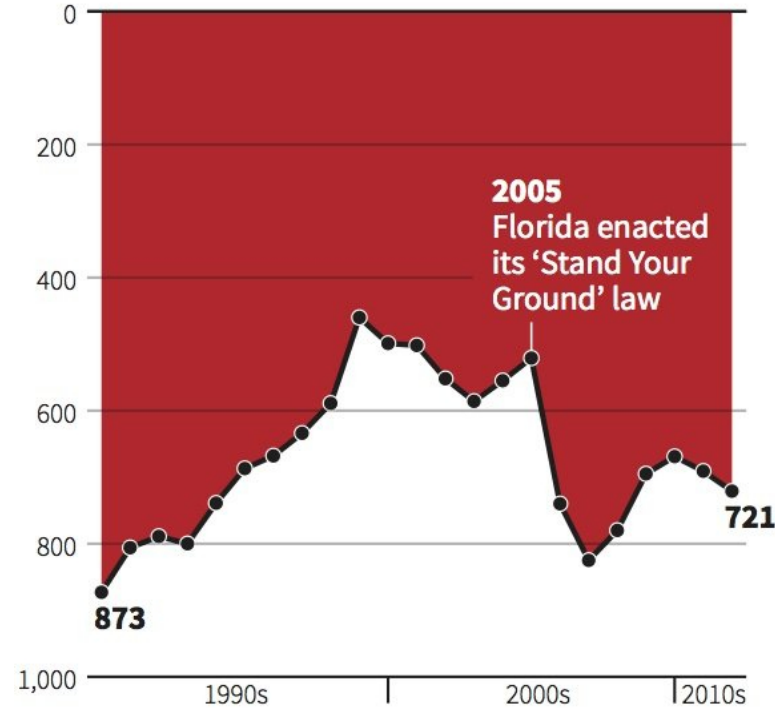
# Background

- Did murders by firearms increase or decrease after the law was enacted?
  - What is your **initial** conclusion (within first second)?
  - What is your **final** conclusion (after a few seconds)?



# Gun deaths in Florida

Number of murders committed using firearms



Source: Florida Department of Law Enforcement

C. Chan 16/02/2014

REUTERS

Source: <http://www.businessinsider.com/gun-deaths-in-florida-increased-with-stand-your-ground-2014-2>

# Discussion

- **Visualization Goals**
  - Why was the y-axis inverted?
- **Perception Problems**
  - Why is the graph not perceived as intended?
- **Design Improvements**
  - What can we try to improve the design?



# Discussion

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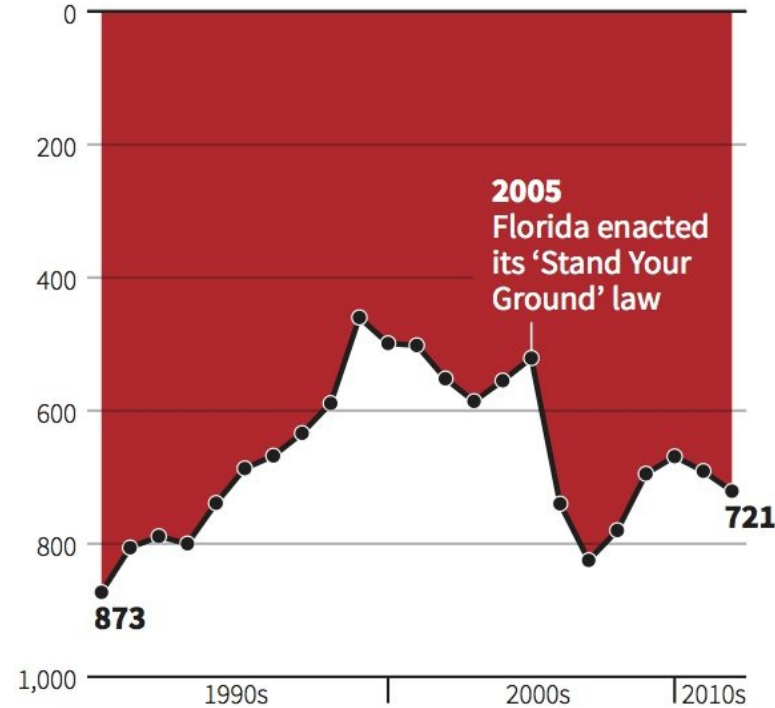
# Visualization Goals

- Can only **speculate** on true intentions for the graph
- Initial claims of **deception** and **misinformation**
- Some evidence that was **non-malicious**



# Gun deaths in Florida

Number of murders committed using firearms



Source: Florida Department of Law Enforcement

C. Chan 16/02/2014

REUTERS

Source: <http://www.businessinsider.com/gun-deaths-in-florida-increased-with-stand-your-ground-2014-2>

# Visualization Goals

**This Chart Shows An Alarming Rise In Florida Gun Deaths After 'Stand Your Ground' Was Enacted**

*Pamela Engel, Business Insider, February 18, 2014*

<http://www.businessinsider.com/gun-deaths-in-florida-increased-with-stand-your-ground-2014-2>



# Visualization Goals

C<sup>2</sup> Christine Chan  
@ChristineHHChan



+ Follow

@john\_self Thanks for the feedback. I prefer to show deaths in negative terms (inverted). It's a preference really, can be shown either way.

↩ Reply ↻ Retweet ★ Favorite ⋮ More

RETWEETS  
12

FAVORITES  
6



12:30 AM - 15 Apr 2014

C<sup>2</sup> Christine Chan  
@ChristineHHChan



+ Follow

@john\_self My inspiration for the graphic:  
[visualisingdata.com/blog/wp-content...](http://visualisingdata.com/blog/wp-content...)

↩ Reply ↻ Retweet ★ Favorited ⋮ More

RETWEETS  
19

FAVORITES  
13



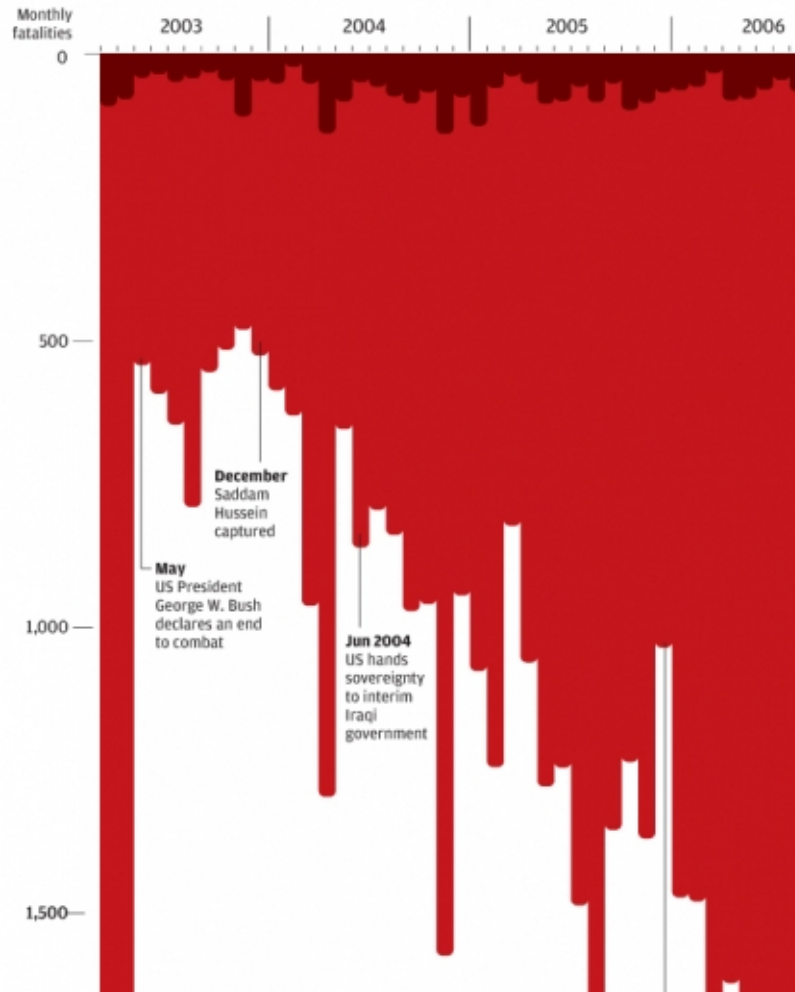
12:31 AM - 15 Apr 2014

<https://twitter.com/ChristineHHChan/status/455971447169511424>

<https://twitter.com/ChristineHHChan/status/455971685783441408>





[illegible]

### Number of murders committed using firearms


**REUTERS**

**The biggest killers**

New cities died, according to the data available\*

\*Invasion to March 29, 2008

**Coalition deaths**

- Air strikes: 1,666
- Roadside bombs: 1,854
- Suicide bombings: 8,708
- Vehicle bombings: 5,340
- Mortar fire: 2,879
- Excavations: 19,706
- Small arms gunfire: 11,877

**Coalition deaths by area**

| Area      | Fatalities |
|-----------|------------|
| Dubai     | 1          |
| Ninawa    | 6          |
| Anbar     | 1,125      |
| Kirkuk    | 286        |
| Salahiyah | 477        |
| Diya      | 12         |
| Waqf      | 2          |
| Erbil     | 227        |
| Musayib   | 43         |
| Haji      | 31         |
| Marham    | 8          |
| Baghdad   | 1,451      |
| Mayaan    | 20         |
| Old Bag   | 99         |
| Basra     | 855        |

**Coalition deaths by country**

| Country              | Deaths |
|----------------------|--------|
| United States        | 4,082  |
| Iraq security forces | 10,125 |
| Others               | 129    |
| Britain              | 179    |

**US ground troops in Iraq**

President Bush approves 21,000 more troops

**Civilian deaths**

113,726

**Coalition deaths**

4,802

**Key Events:**

- March 2003: US-led forces invade
- May: US President George W. Bush declares an end to combat
- December: Saddam Hussein captured
- June 2004: US hands sovereignty to interim Iraqi government
- August 2005: 9/11 blast in a single incident when floor of an insurgent attack caused a huge crowd of Shiite pilgrims to stampede on a bridge
- January 2007: Bush announces a surge of extra troops will be deployed
- December 2006: Saddam Hussein executed
- January 2009: US forces cross under Iraqi mandate, Central of Green Zone handed to Iraq

The United States officially marked the end of almost nine years of bloody military engagement in Iraq on Thursday. Over 4,800 coalition soldiers and tens of thousands of Iraqis lost their lives in a war that defined a decade.

# Discussion

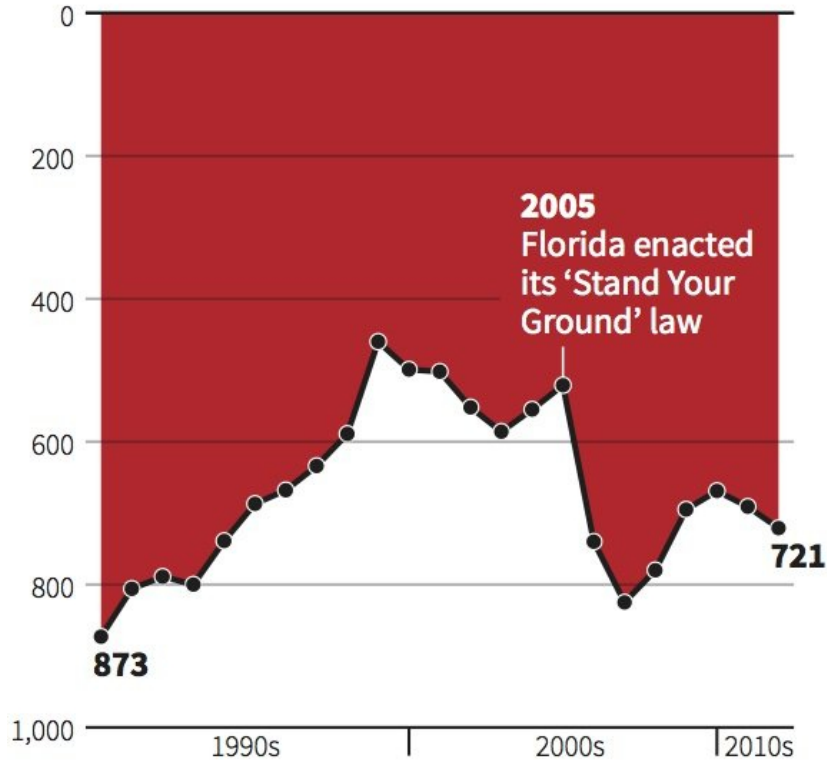
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# Gun deaths in Florida

Number of murders committed using firearms

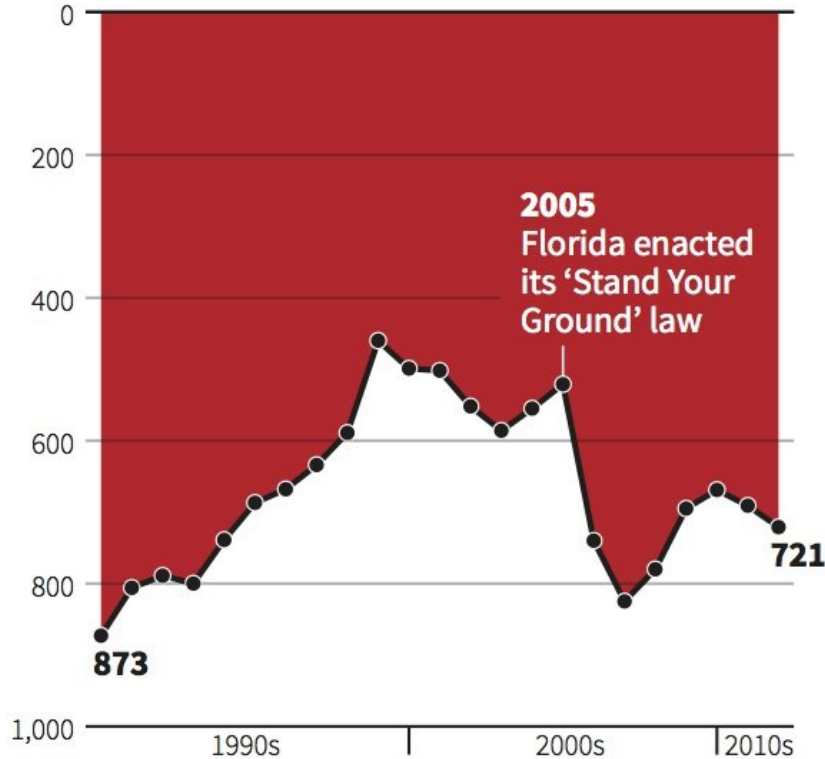


Source: Florida Department of Law Enforcement

- If you focus on the **red area**, you see an **increase**
- If you focus on the **white area**, you see a **decline**
- If you focus on the **black line**, you see a **decline**

# Gun deaths in Florida

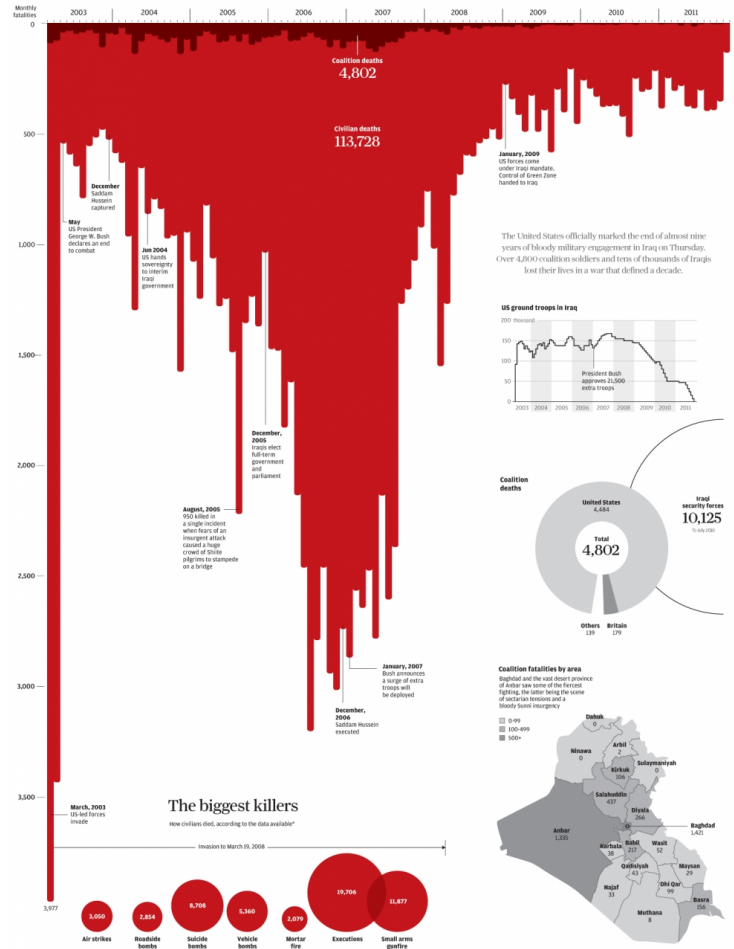
Number of murders committed using firearms



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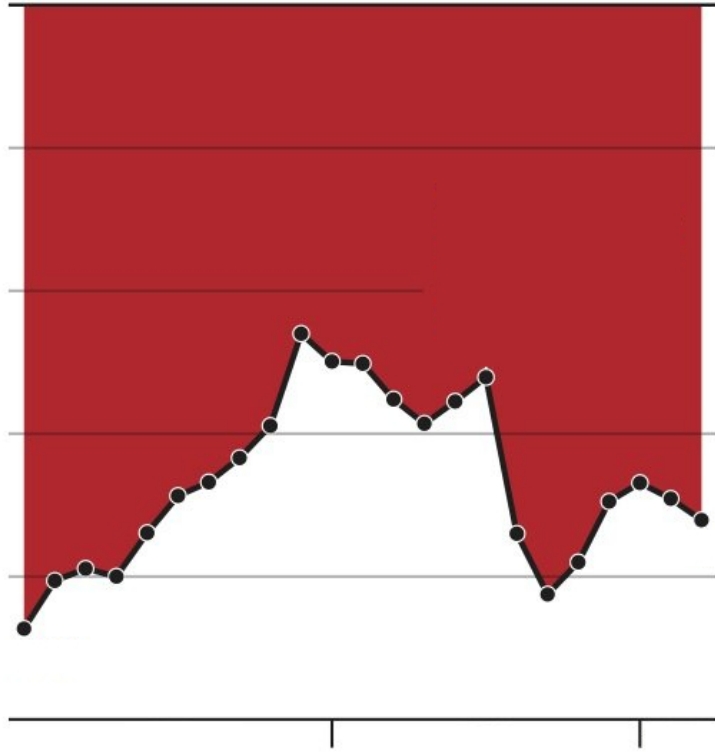
C. Chan 16/02/2014

# Iraq's bloody toll



# Gun deaths in Florida

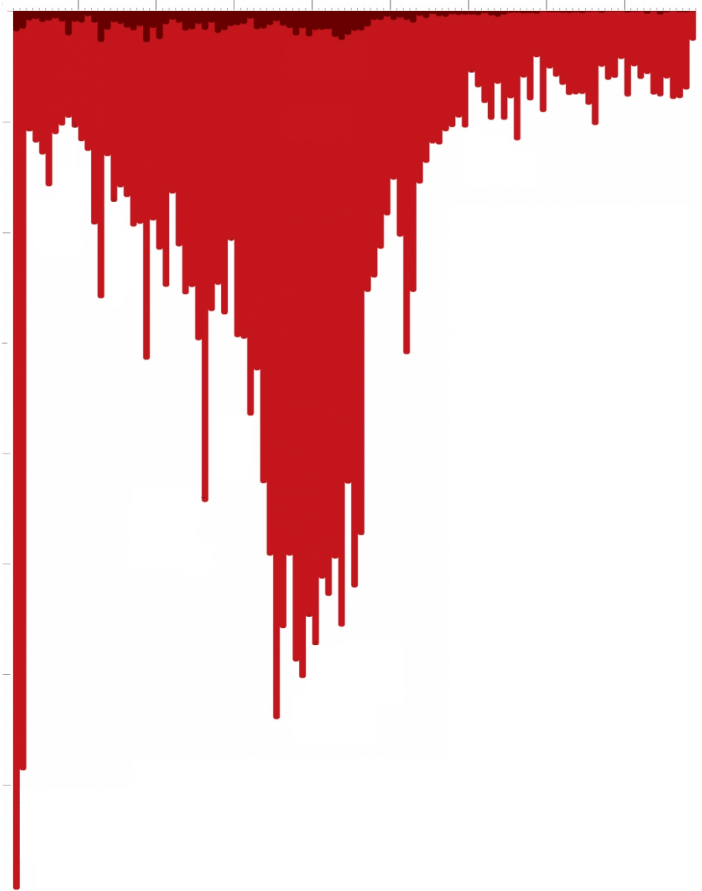
Number of murders committed using firearms



Source: Florida Department of Law Enforcement

C. Chan 16/02/2014

# Iraq's bloody toll



### Number of murders committed using firearms



C. Chan 16/02/2014


**REUTERS**

**The biggest killers**

How civilians died, according to the data available\*

Invaction to March 29, 2008

| Weapon          | Civilians Killed |
|-----------------|------------------|
| Air strikes     | 3,977            |
| Roadside bombs  | 3,060            |
| Suicide bombers | 2,804            |
| Vehicle bombs   | 6,708            |
| Mortar fire     | 5,360            |
| Missiles        | 2,879            |
| Escalators      | 19,704           |
| Small arms      | 11,877           |

**Coalition deaths**

| Country              | Deaths |
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| United States        | 4,082  |
| Iraq security forces | 10,125 |
| Others               | 139    |

**Coalition fatalities by area**

Baghdad and the west have the greatest number of deaths, the latter being the scene of sectarian tensions and a bloody Shiite insurgency

| Area    | Fatalities |
|---------|------------|
| Baghdad | 1,315      |
| West    | 1,077      |
| South   | 43         |
| East    | 29         |
| North   | 8          |
| Other   | 99         |

**US ground troops in Iraq**

200 thousand

President Bush approves 21,000 extra troops

**Coalition deaths**

United States 4,082

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Others 139

**The biggest killers**

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<sup>a</sup>Deaths from unknown causes are not included. Causes of death were defined as less than 15 years post-diagnosis, distant to breast, or unknown.

Source: U.S. Office of the Death Count, New England Journal of Medicine, Global Section, American Medical Association.

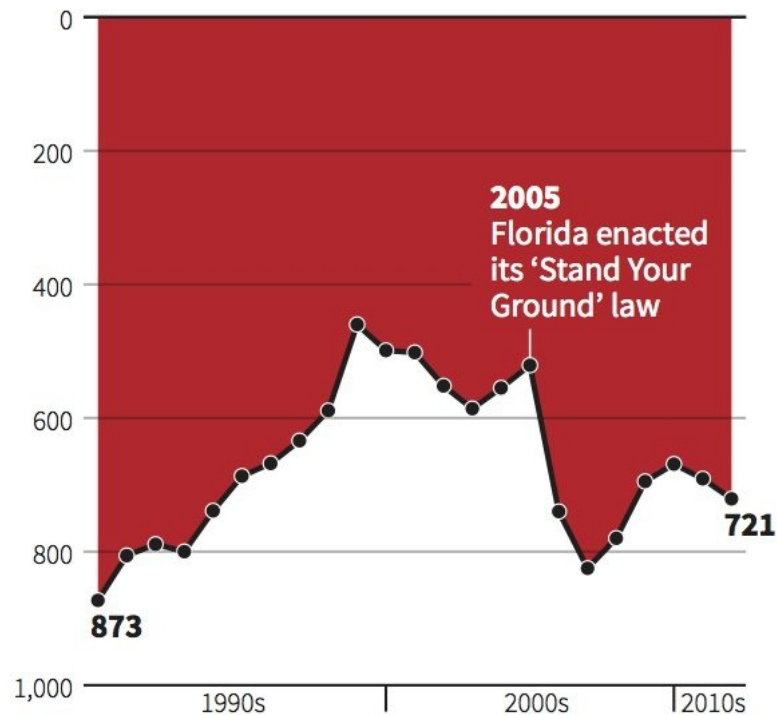
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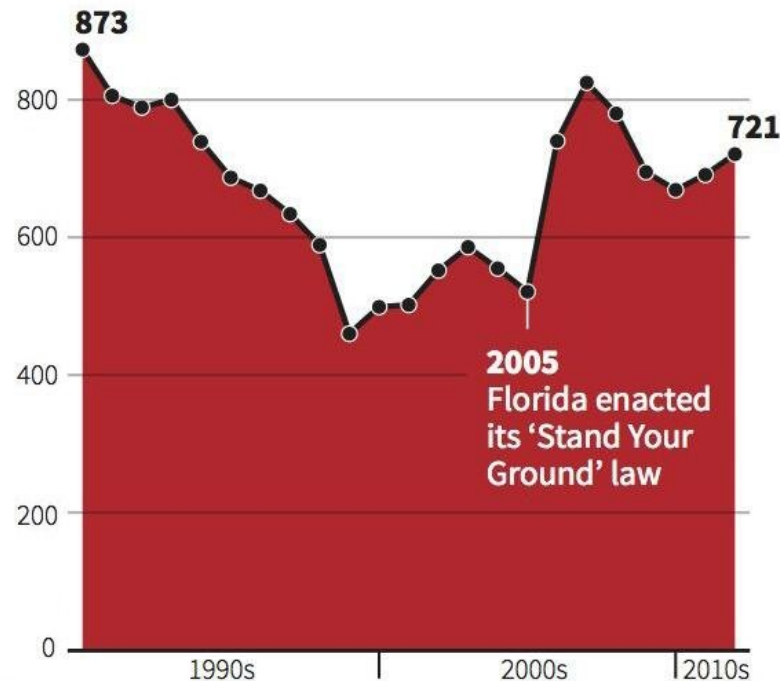
Source: Florida Department of Law Enforcement

C. Chan 16/02/2014



# Gun deaths in Florida

Number of murders committed using firearms



Source: Florida Department of Law Enforcement

# Original Data Source

## **Florida Department of Law Enforcement Uniform Crime Reports (UCR) Offense Data**

Murder: Firearm Type and Rate for Florida, 1971 – 2013

Total by Firearm (See 1990 to 2012)

<http://www.fdle.state.fl.us/Content/getdoc/8c4ed844-de81-4551-a10e-7eb31e76def0/UCR-Offense-Data.aspx>



# Original Data Source

| Year | Deaths |
|------|--------|
| 1990 | 873    |
| 1991 | 806    |
| 1992 | 789    |
| 1993 | 800    |
| 1994 | 739    |
| 1995 | 687    |
| 1996 | 668    |
| 1997 | 634    |

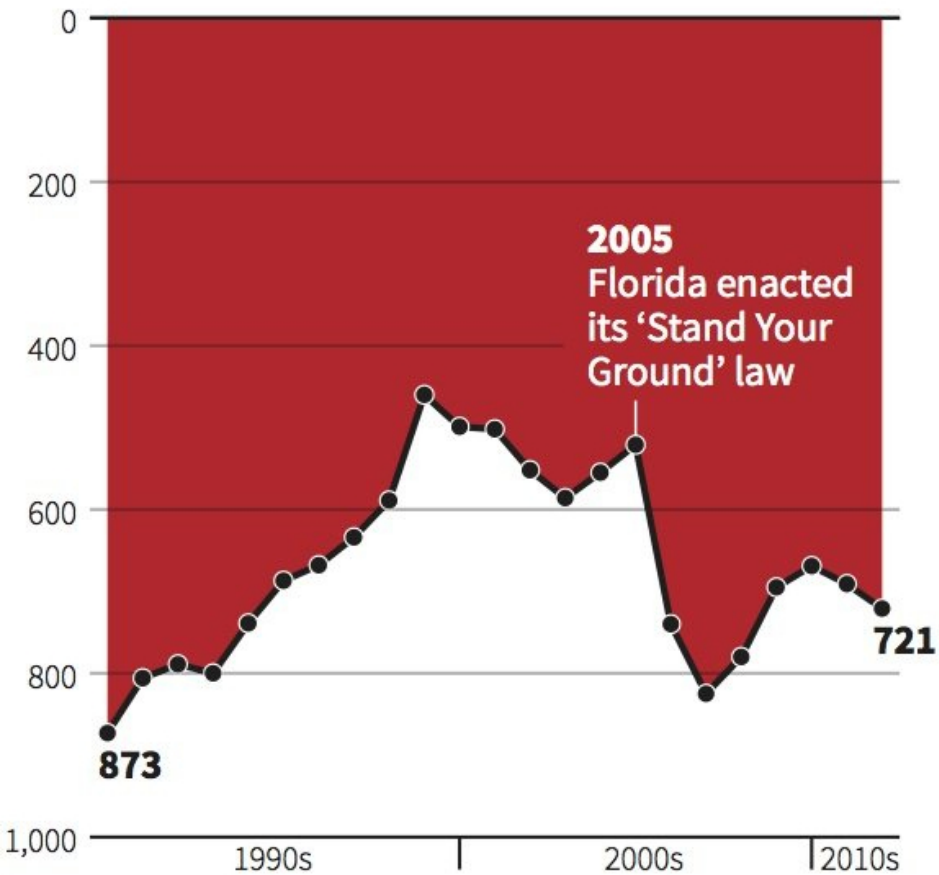
| Year | Deaths |
|------|--------|
| 1998 | 589    |
| 1999 | 460    |
| 2000 | 499    |
| 2001 | 502    |
| 2002 | 552    |
| 2003 | 586    |
| 2004 | 555    |
| 2005 | 521    |

| Year | Deaths |
|------|--------|
| 2006 | 740    |
| 2007 | 825    |
| 2008 | 780    |
| 2009 | 695    |
| 2010 | 669    |
| 2011 | 691    |
| 2012 | 721    |

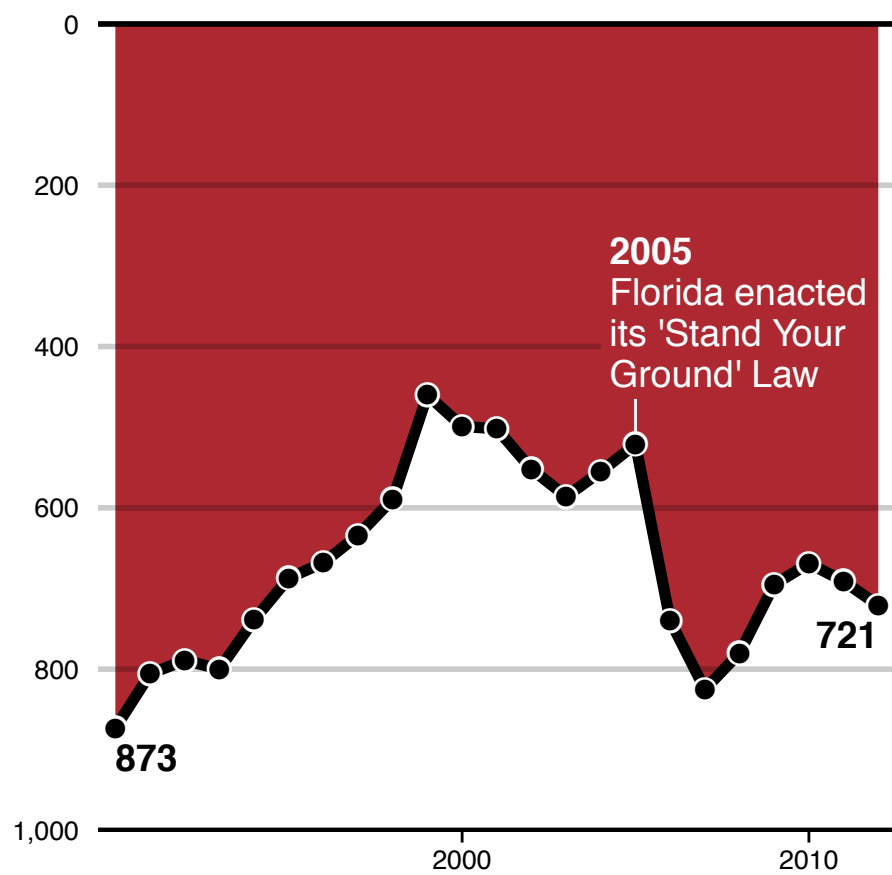
<http://www.fdle.state.fl.us/Content/getdoc/8c4ed844-de81-4551-a10e-7eb31e76def0/UCR-Offense-Data.aspx>



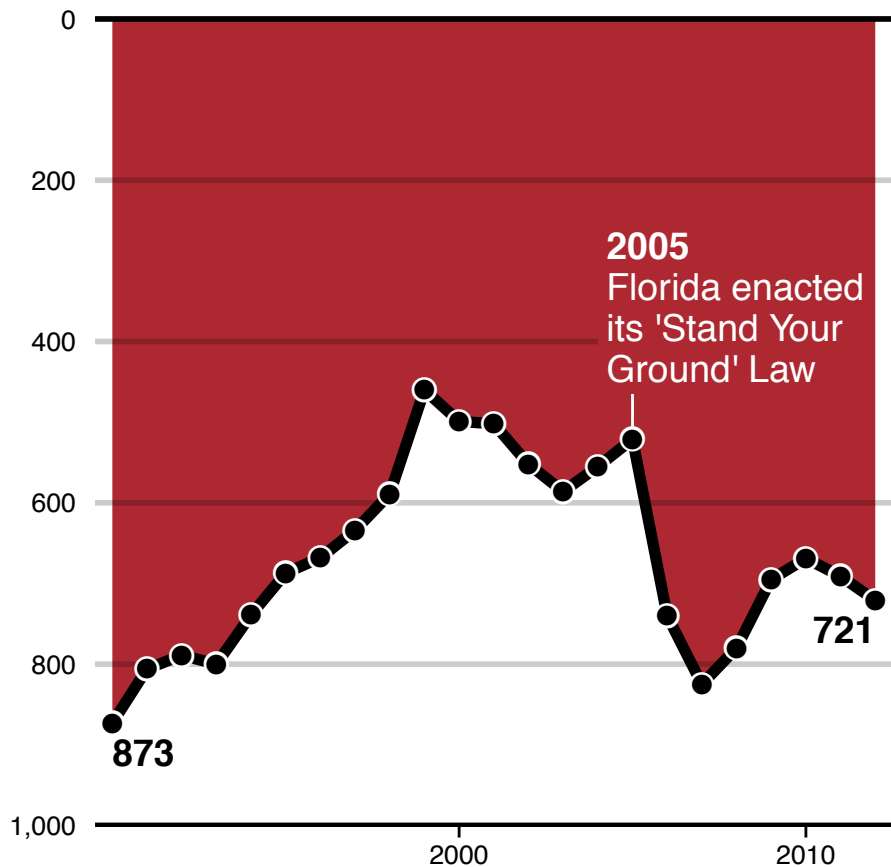




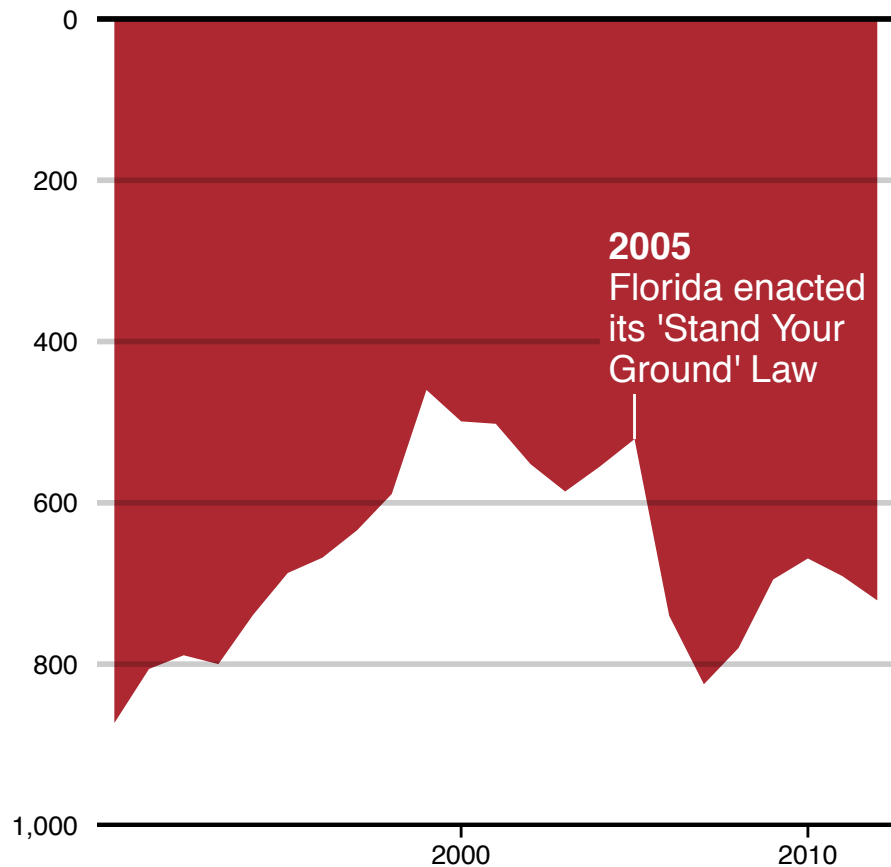
Original Graph (Core Only)



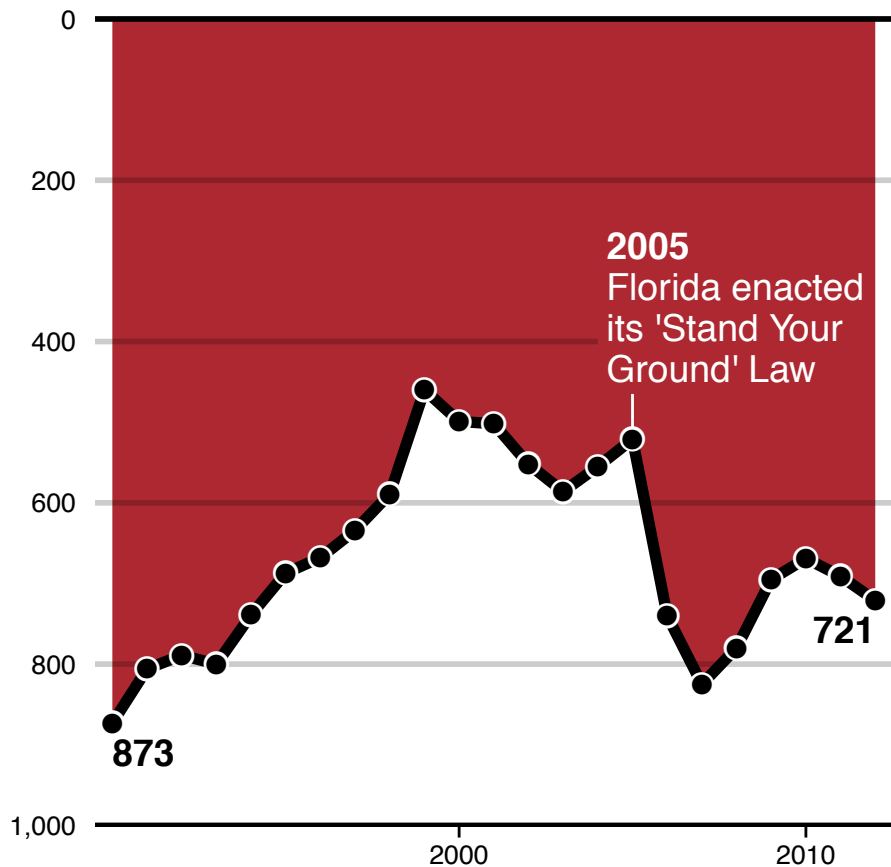
Recreated in R and ggplot2



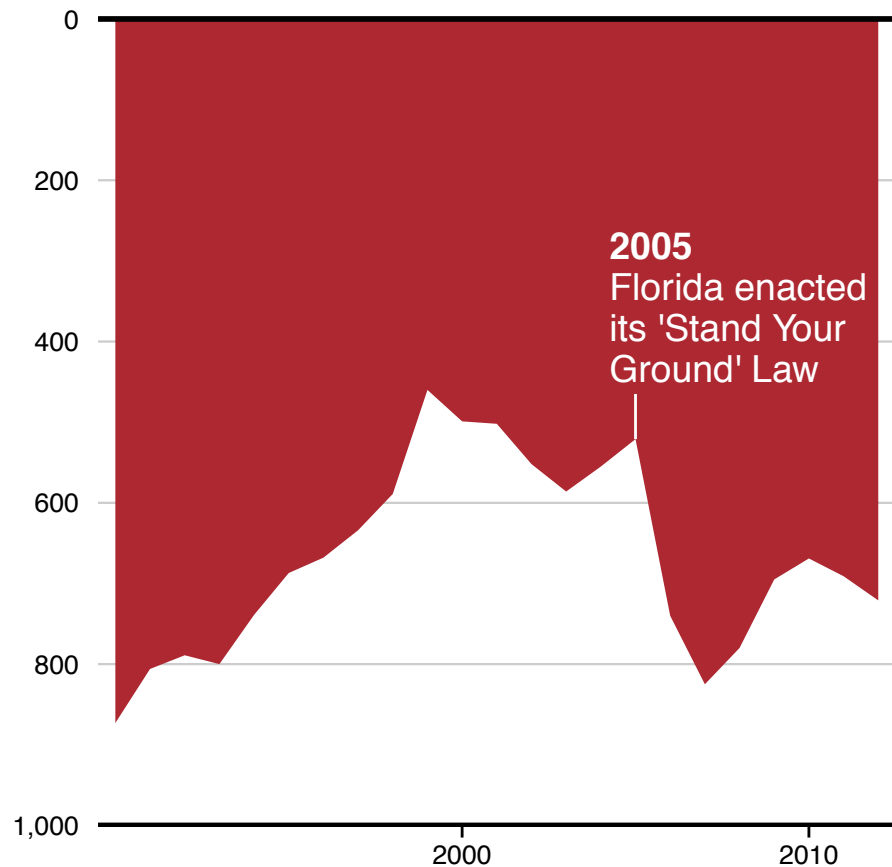
Recreation



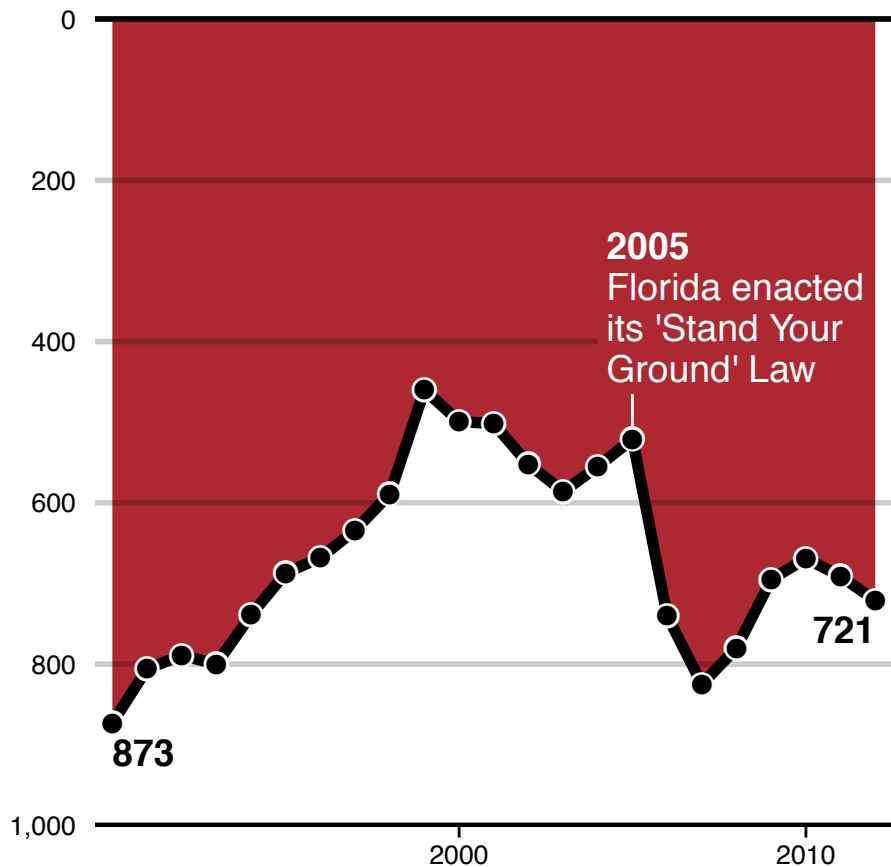
Remove heavy black line, points, and annotation



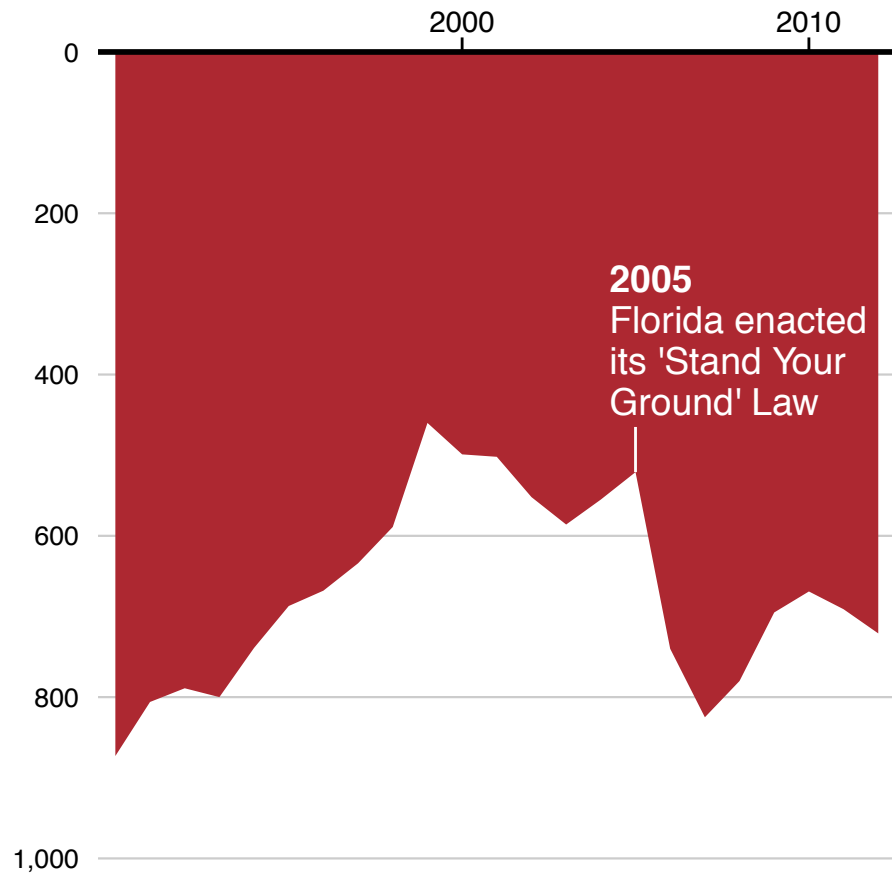
Recreation



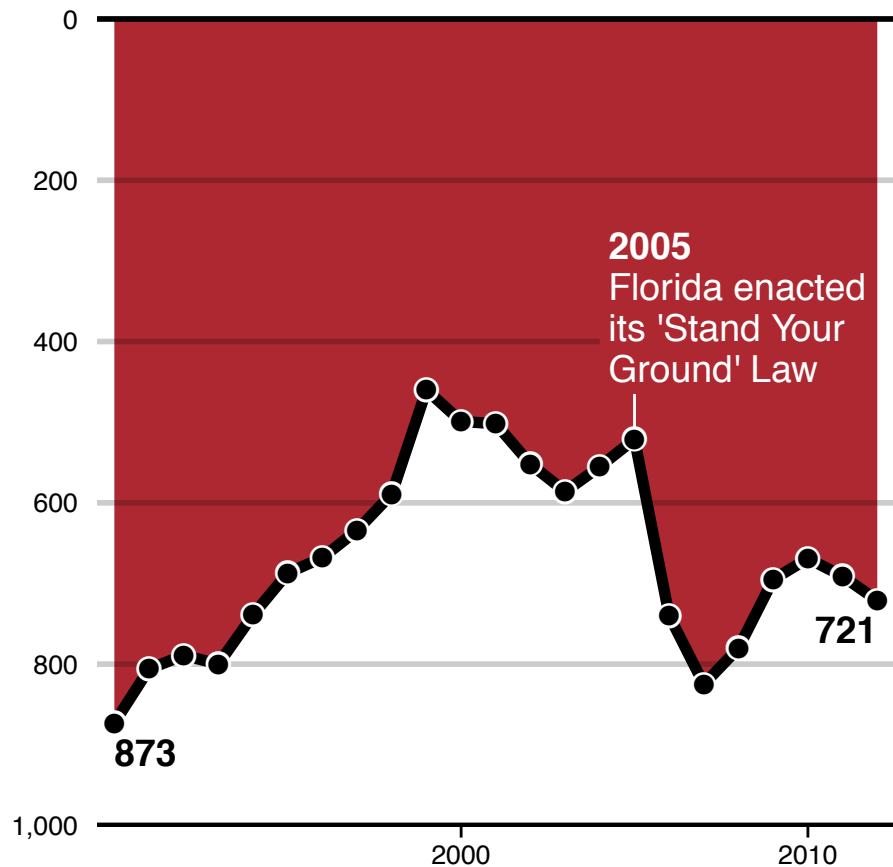
Move grid lines to background and lighten



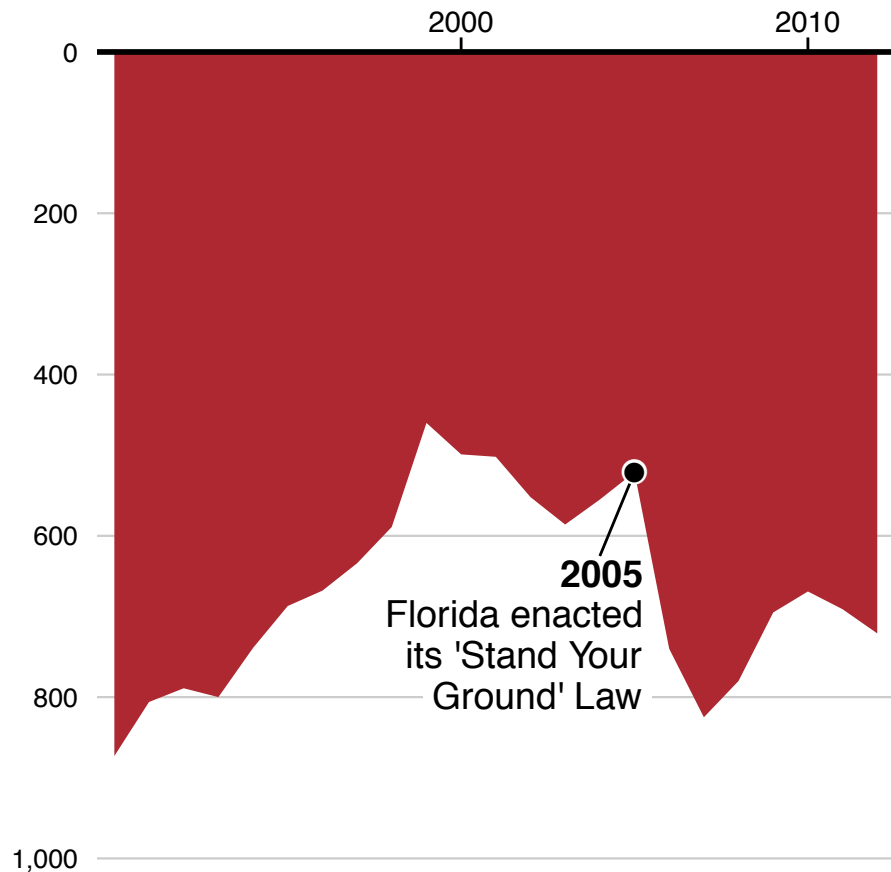
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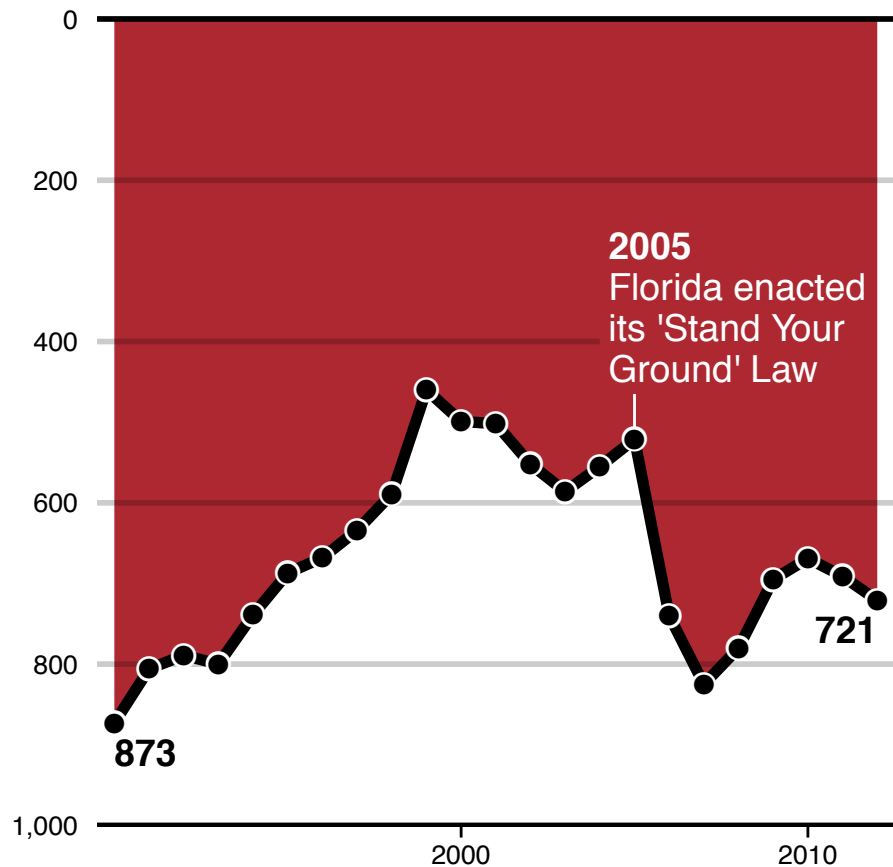
Move x-axis scale to top



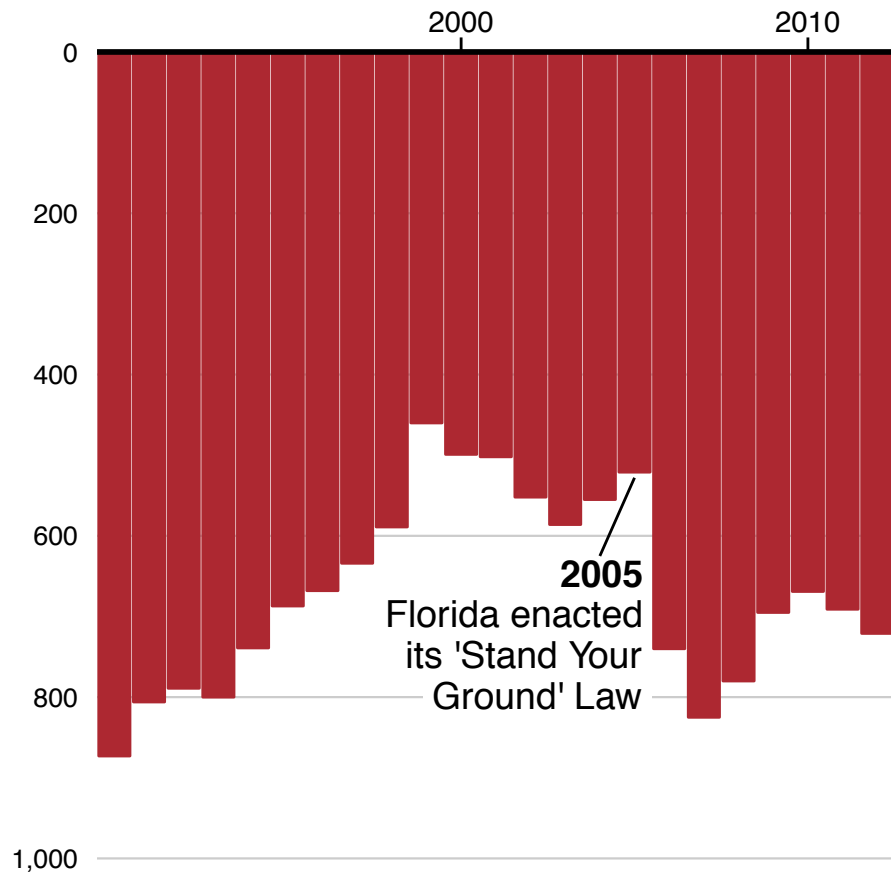
Recreation



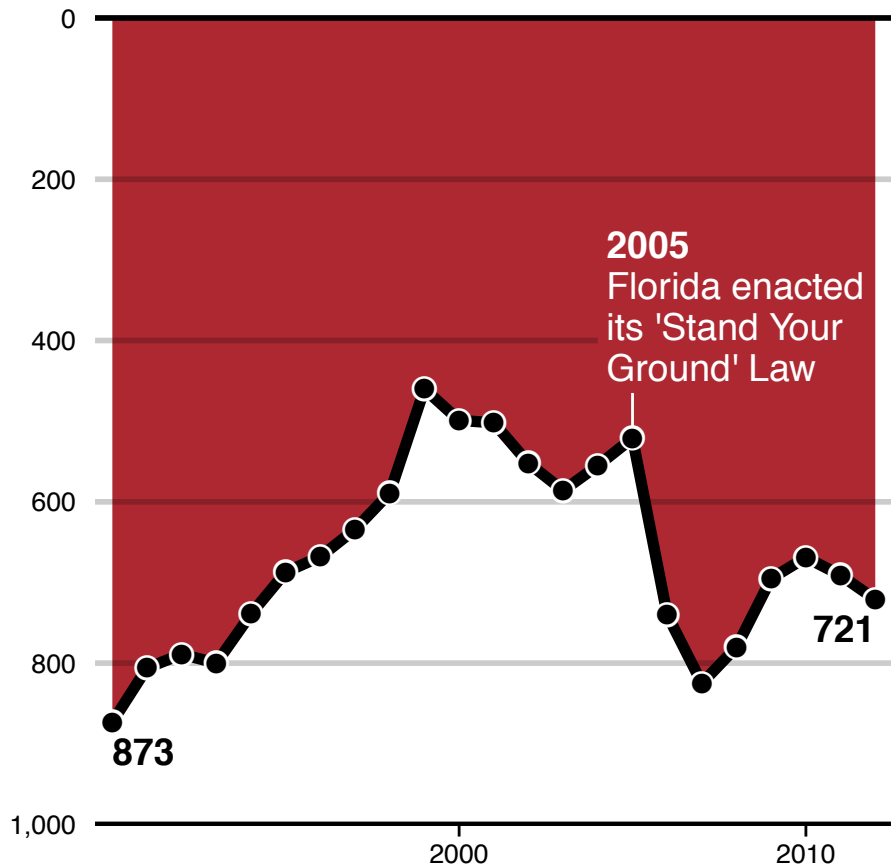
Move annotation



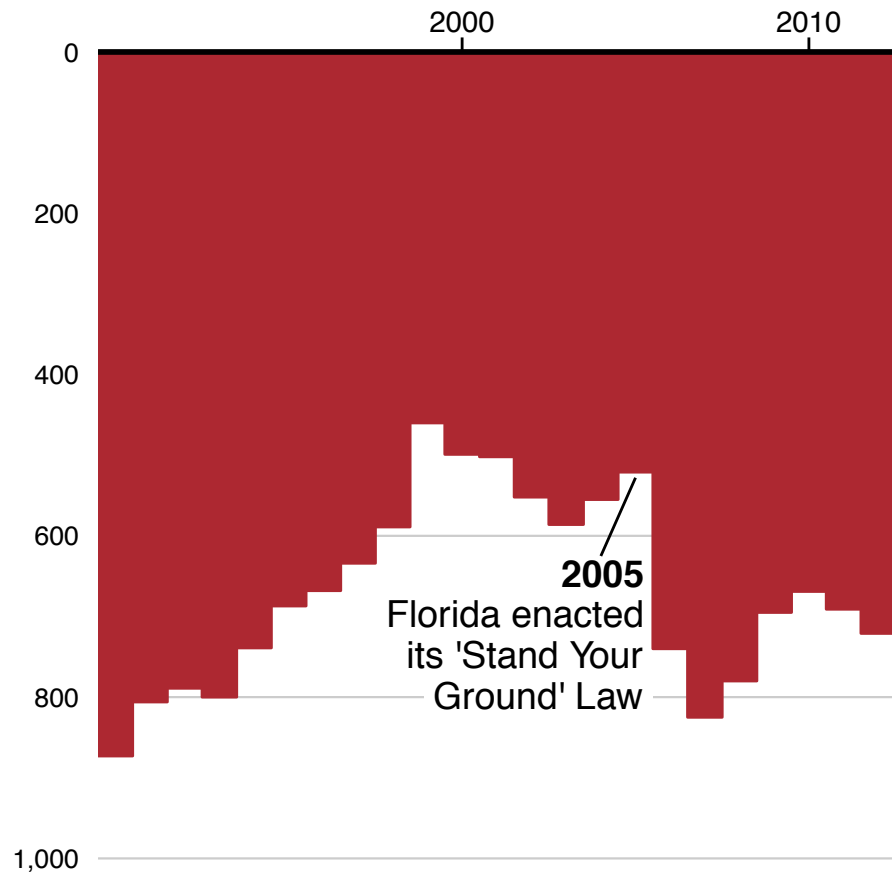
Recreation



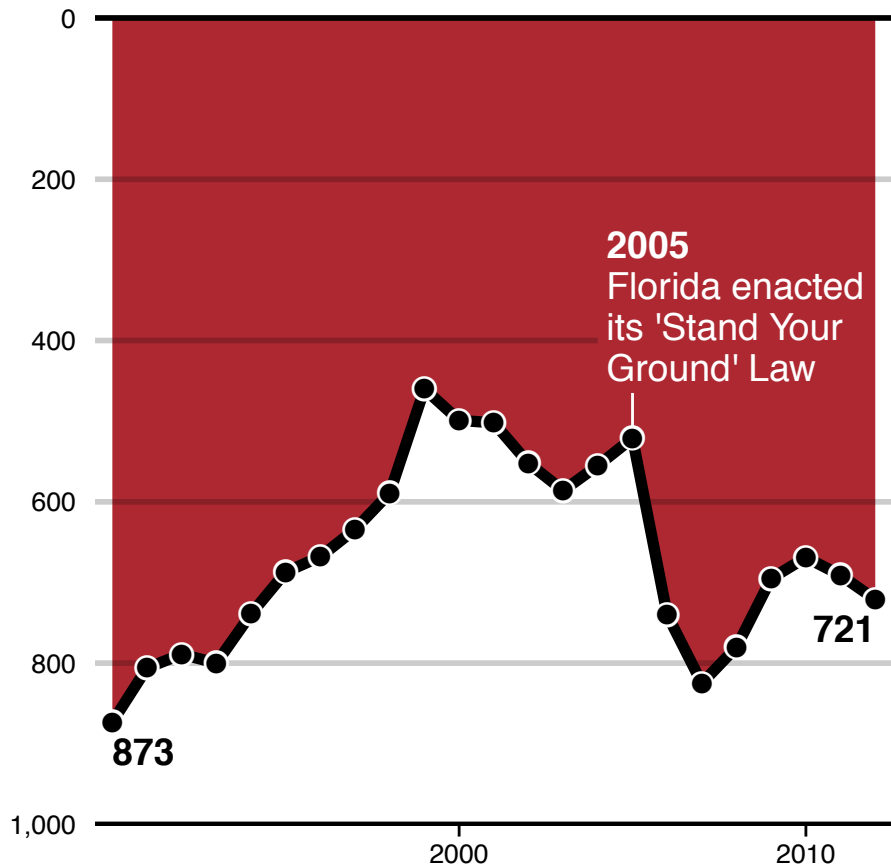
Switch to bars



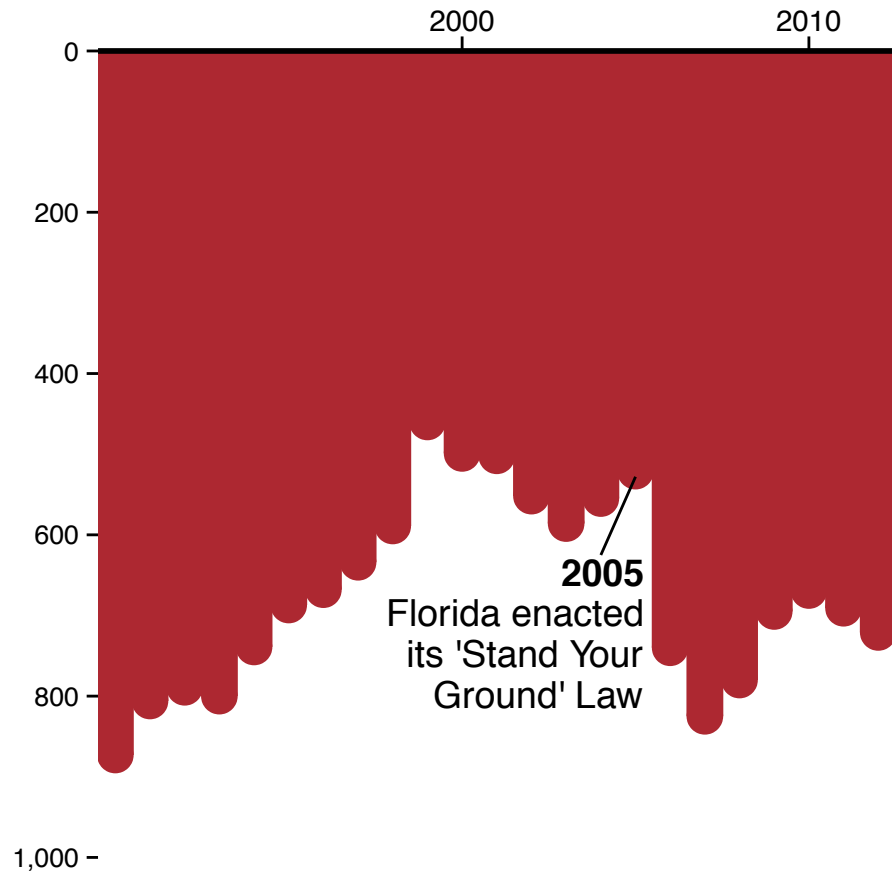
Recreation



Make bars more solid

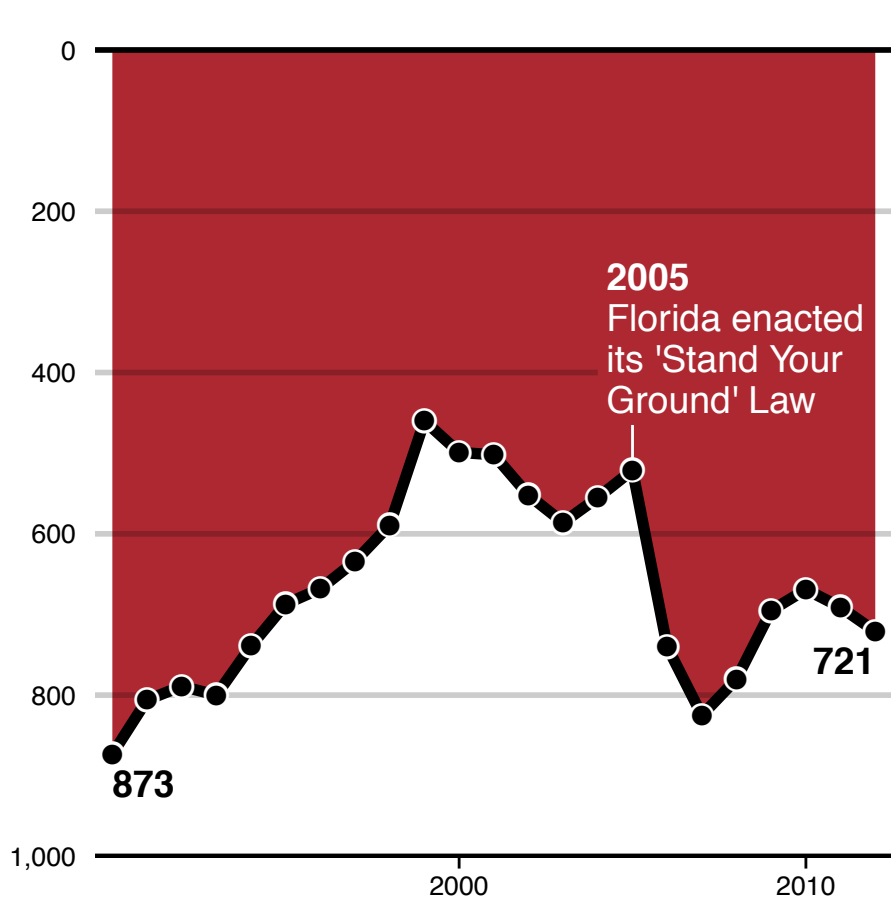


Recreation

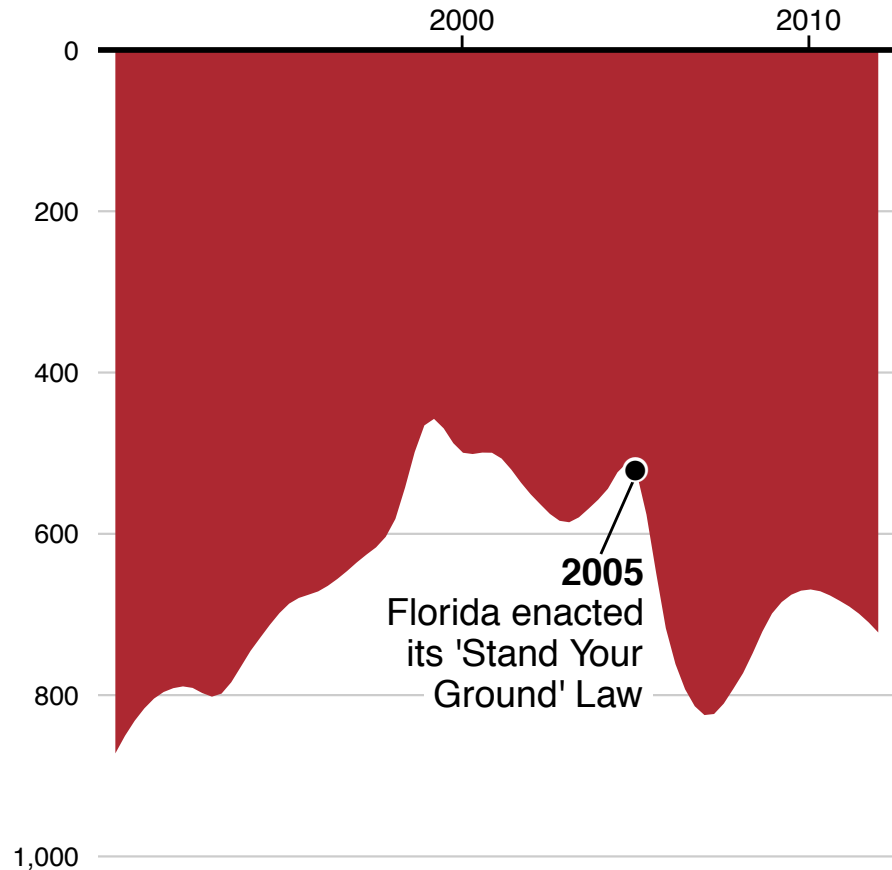


Trying rounded bars with no grid

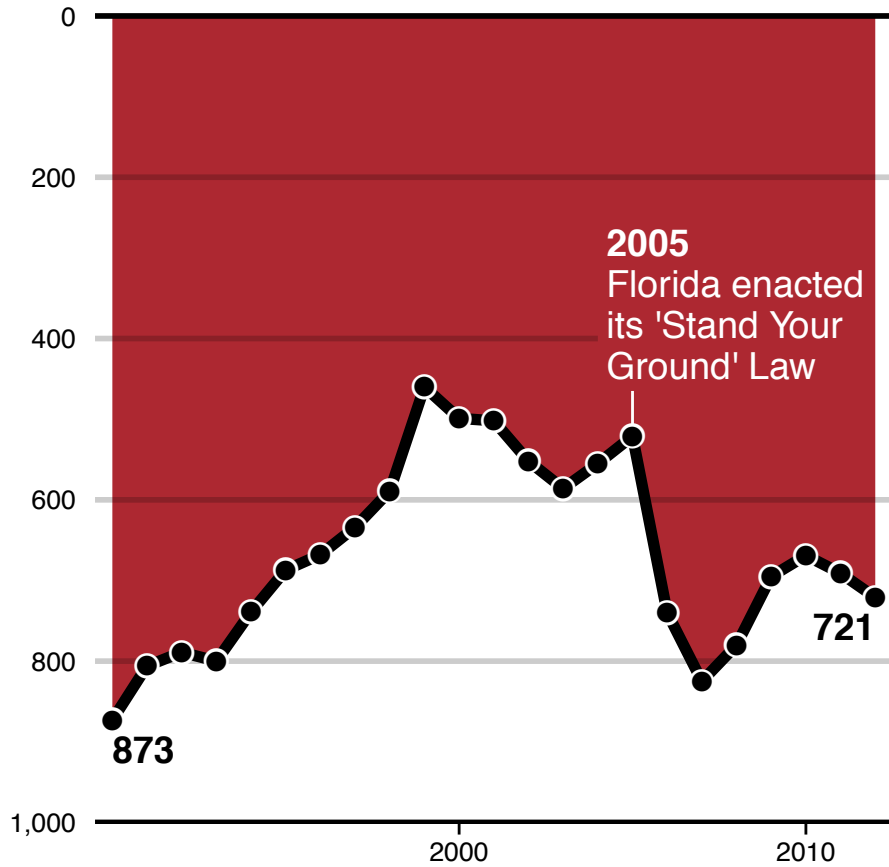




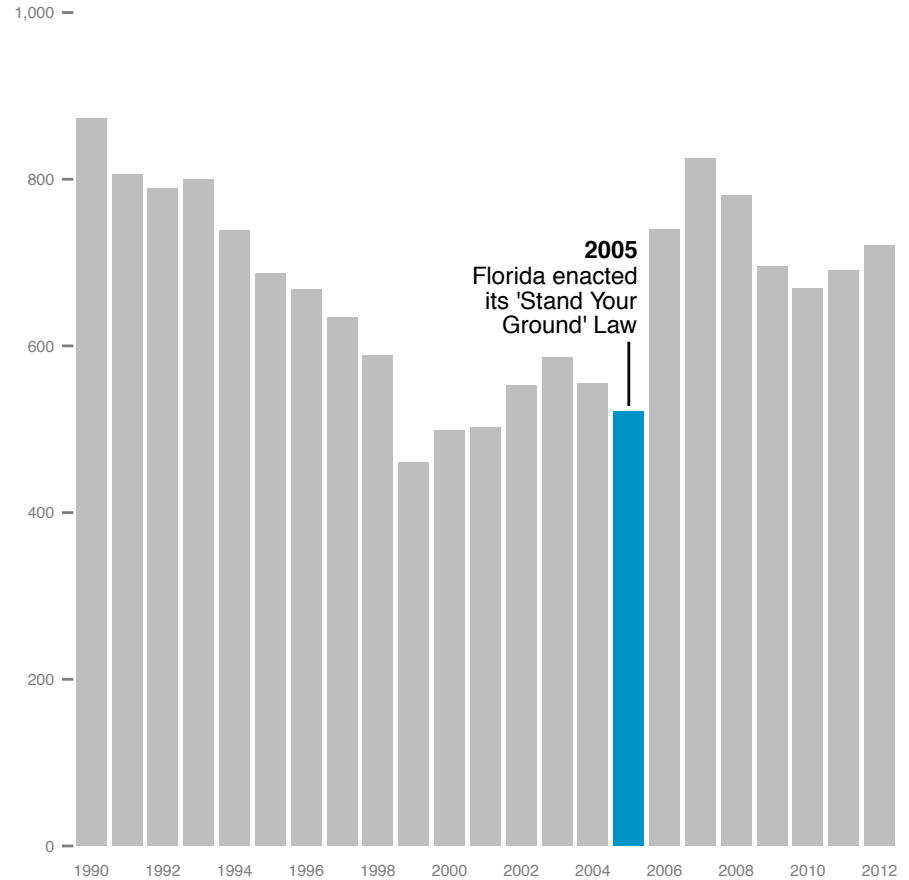
Recreation



Back to area, but using smoothing

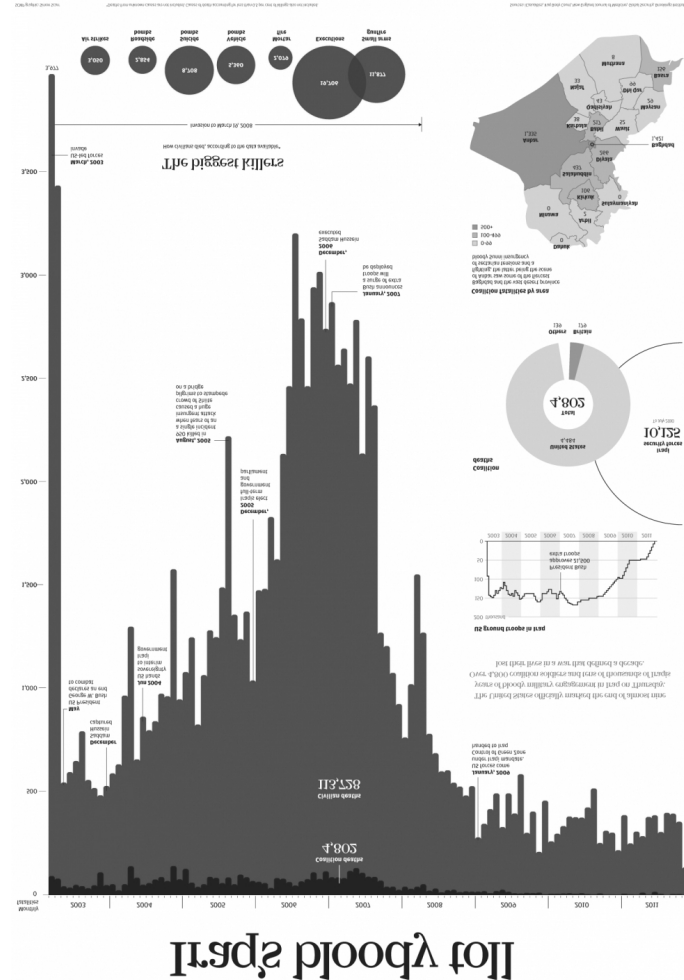
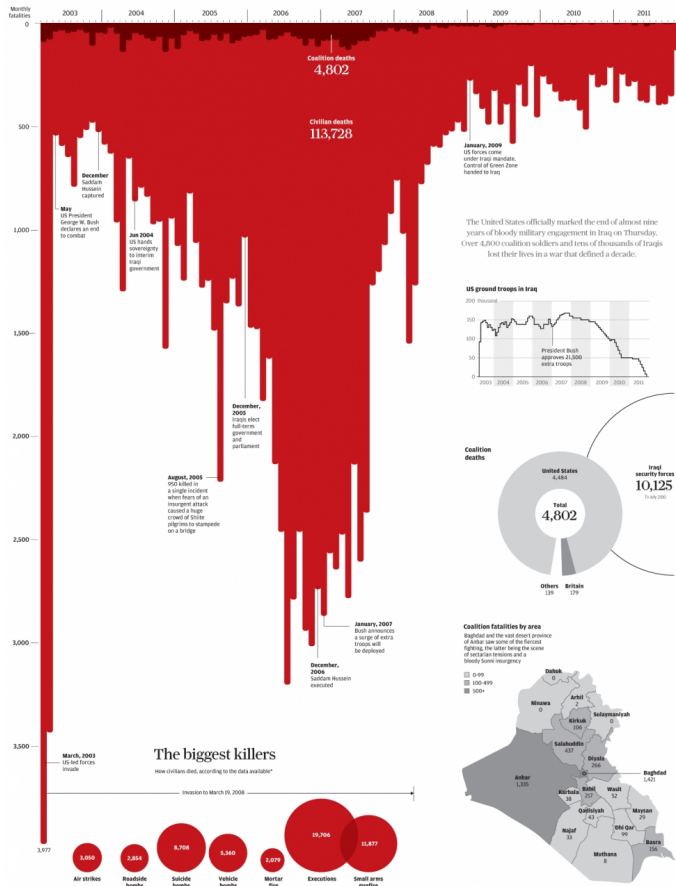


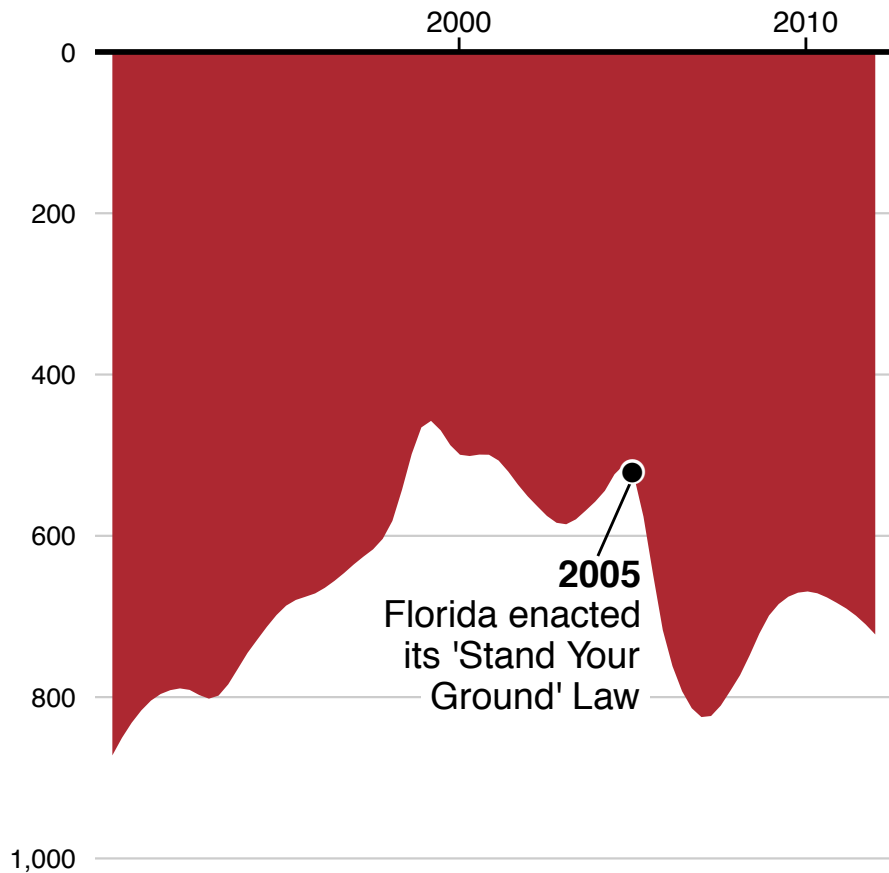
Recreation



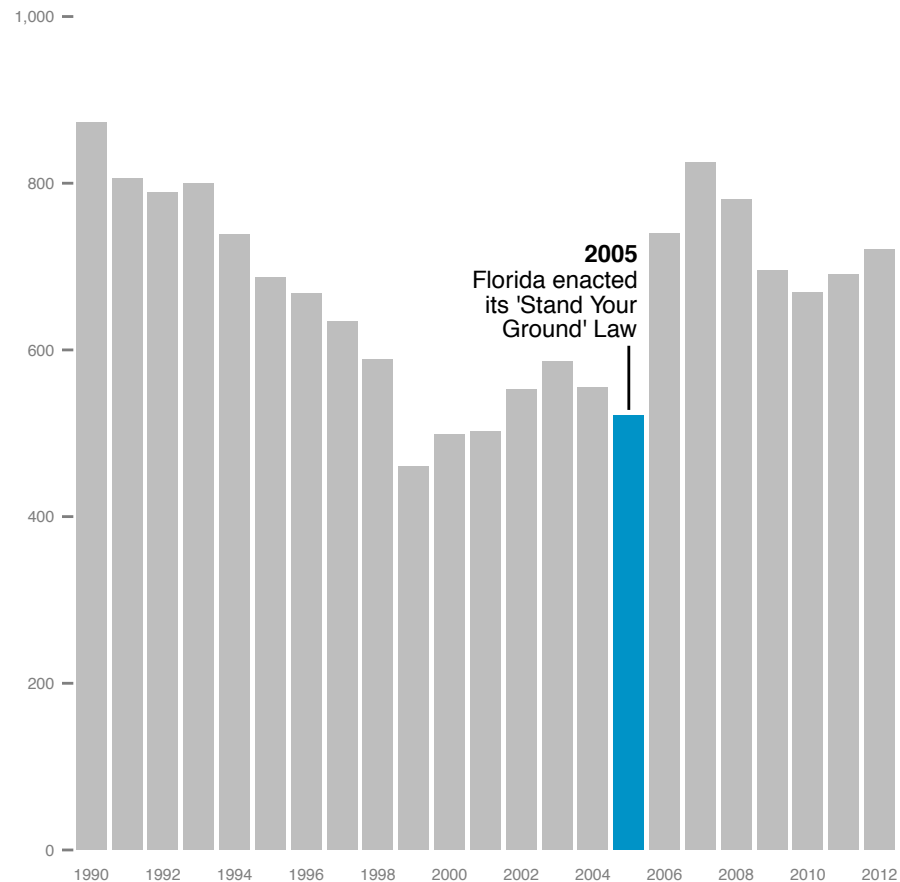
Normal bar

# Iraq's bloody toll





Inverted area



Normal bar

# References

- “This Chart Shows An Alarming Rise In Florida Gun Deaths After ‘Stand Your Ground’ Was Enacted,” Pamela Engel, Business Insider, February 18, 2014.  
<http://www.businessinsider.com/gun-deaths-in-florida-increased-with-stand-your-ground-2014-2>
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<http://www.scmp.com/infographics/article/1284683/iraqs-bloody-toll>
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- “Conventions, novelty and the double edge,” Kaiser Fung, Junk Charts, April 15, 2014.  
[http://junkcharts.typepad.com/junk\\_charts/2014/04/conventions-novelty-and-the-double-edge.html](http://junkcharts.typepad.com/junk_charts/2014/04/conventions-novelty-and-the-double-edge.html)
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<http://www.fdle.state.fl.us/Content/getdoc/8c4ed844-de81-4551-a10e-7eb31e76def0/UCR-Offense-Data.aspx>

And many more Twitter and blog posts...



# QUESTIONS

<http://sjengle.cs.usfca.edu/>

