Designing Effective Information Graphics

An informal presentation to the Western Intergovernmental Audit Forum

September 13, 2013

GAO

Some thoughts to get us going…

Clarity and excellence in thinking is very much like clarity and excellence in the display of data. When principles of design replicate principles of thought, the act of arranging information becomes an act of insight.

—Edward Tufte, *Visual Explanations*

Elegance [of graphics] is often found in simplicity of design and complexity of data.

—Edward Tufte, *The Visual Display of Quantitative Information*

What graphics can do for…

Writers

- Organizes information and aids with analysis
- Saves room for text (seriously)

Readers

- Supports and supplements analysis of the information
- Aids in understanding of complex ideas
- Makes the message more understandable, accessible, and memorable
- Fosters sharing on social media

Getting to the point: Text to table

	Defined Benefit (DB)	Defined Contribution (DC)
What is it?	A monthly payment during retirement based on the employee's salary and tenure	A pool of cash, enhanced by financial investment, that can be drawn upon during retirement [i.e. 401(k)]
Who finances the plan?	Employer, who bears all costs	Worker, often with a limited employer match
Who manages the plan?	Employer, who selects provider and may select investments	Employer selects provider, but most plans allow worker to select investments
How do the contribution costs compare?	Costs born entirely by employer Costs can fluctuate, but are generally smoothed by amortization	Costs shared by worker and employer Less fluctuation in costs, but payments must be pre-funded or made immediately
Advantages for workers	Dependable lifetime income Benefit grows with length of service	Portable Investment gains can increase available cash
Disadvantages for workers	Not portable Workers who change jobs earn a smaller benefit	Investment losses can decrease available cash No reward for length of service
Advantages for employers	Can serve a worker retention tool	Workers bear all risk of investments
Disadvantages for employers	Employer solely responsible for funding monthly payments and bears all risk of investments	Portable, so less valuable as a retention tool Higher administrative costs

Getting to the point: Text to figure

The Corrosion Office Used a Rigorous Multistep Process to Select Projects for Funding

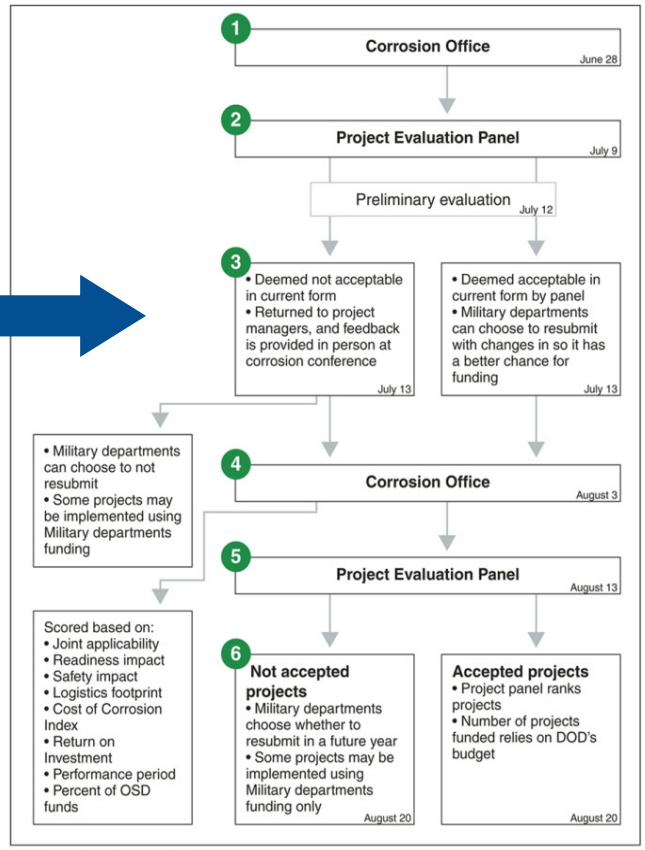
For the fiscal year 2011 project review and selection, we observed that the Corrosion Office used a rigorous multistep process to determine if proposed projects were acceptable for funding.

- **Step 1:** In mid-June 2010, the military departments submitted 81 CPC project proposals to the Corrosion Office, as shown in table 1 above. At this point, Corrosion Office support staff assembled the project plans into binders for review by the project selection panel convened by the Director of the Corrosion Office. The fiscal year 2011 panel had five members: the Director, Corrosion Office (chair); Associate Director, Materials and Structures, Office of the Director, Defense Research & Engineering (vice-chair); and an official from each of the following organizations within the Office of the Under Secretary of Defense (Acquisition, Technology and Logistics): Defense Acquisition University; Installations and Environment; and Logistics and Materiel Readiness, Maintenance Policy and Programs.[18]
- **Step 2:** In mid-July 2010, 2 weeks after project information was provided to the panel, the panel members assembled for their preliminary evaluation of the proposals. This preliminary evaluation, which we observed, was conducted at a meeting immediately prior to the annual DOD Corrosion Forum and resulted in projects being designated as either a "go" (meaning that the projects are deemed acceptable in their current form) or a "no go" (meaning that the projects require additional information or changes in scope to be acceptable to the panel). We observed that the panel used criteria for this preliminary evaluation that are not made available to the submitters of project proposals and are different from those used for final project selection later in the process.[19]
- **Step 3:** Following the preliminary evaluation and during the Corrosion Forum, the panel held individual feedback sessions with project managers from the military commands, such as Naval Air Systems Command, Army Aviation and Missile Command, and Air Force Civil Engineer Support Agency, so feedback could be done in person. The panel provided feedback on each project, regardless of whether it was designated as a "go" or "no go." A panel member told us that the panel provided feedback on all projects so that project managers could address—if they choose to do so—any perceived weaknesses in their "go" projects and improve their ranking in the final evaluation, as well as revise the "no go" project submissions. Following the feedback, the project managers had three options: prepare and submit information addressing the feedback provided by the panel, re-submit project proposals in their original form, or remove projects from consideration for that year's funding process. Project managers told us that they sometimes decide to remove their "no-go" projects from consideration and that the military departments may implement such projects using other funding. A project selection panel member told us that if a project manager decided to modify a project proposal to address the panel's feedback, this modified proposal was due to the Corrosion Office no later than 2 weeks after the feedback session. Upon receipt of any revised proposals, the panel conducted another review of all proposals (original and resubmitted), which involved each panel member independently scoring the projects on judgmental criteria and providing written comments.[20]
- **Step 4:** In mid-August 2010, Corrosion Office support staff used an analytical tool to rank the projects based on the average of the scores recorded by each panel member for eight criteria: the five judgmental criteria above and three quantitative criteria—ROI, Corrosion Office funding as a percentage of total project cost, and the project performance, or implementation, period.
- **Step 5:** Following the ranking of projects using the analytical tool, the selection panel reconvened for a final evaluation of the projects. The panel arranged the ranked list that resulted from the analytical tool described above into four categories: best, acceptable–prioritized for funding, acceptable–not prioritized, and not acceptable. According to the staff, the "best" projects would likely all be funded, the "acceptable–prioritized for funding" projects would be funded by priority until the Corrosion Office funding is exhausted. Corrosion Office support staff informed the panel that, based on historical funding levels, they anticipated having $7 million in available funding

[18] The panel member from Logistics and Materiel Readiness, Maintenance Policy and Programs did not participate in the project selection meetings we observed.

[19] The criteria used for the preliminary evaluation include whether the proposed project requires greater than $500,000 of Corrosion Office funds to complete, uses similar technology to a previously approved project, or is anticipated to take more than 2 years to complete. The preliminary evaluation did not consider the joint applicability of the project, but this was a criterion in the final project evaluation.

[20] The judgmental criteria are: joint applicability, readiness impact, safety impact, logistics benefits, and anticipated contribution of the project to reducing the cost of corrosion. Corrosion Office officials told us that they believe the criteria to be clearly identified in the DOD *Corrosion Prevention and Mitigation Strategic Plan*.



Source: GAO analysis of OSD selection process.

What is a graphic?

- "Graphic" is a generic term that can mean almost kind of visual element…
  - **Charts** give readers a picture of numerical data
  - **Diagrams** show how parts interact
  - **Maps** depict geographic relationships
  - **Illustrations** (including icons, logos)

Not quite a graphic

- **Tables** arrange information in rows and columns

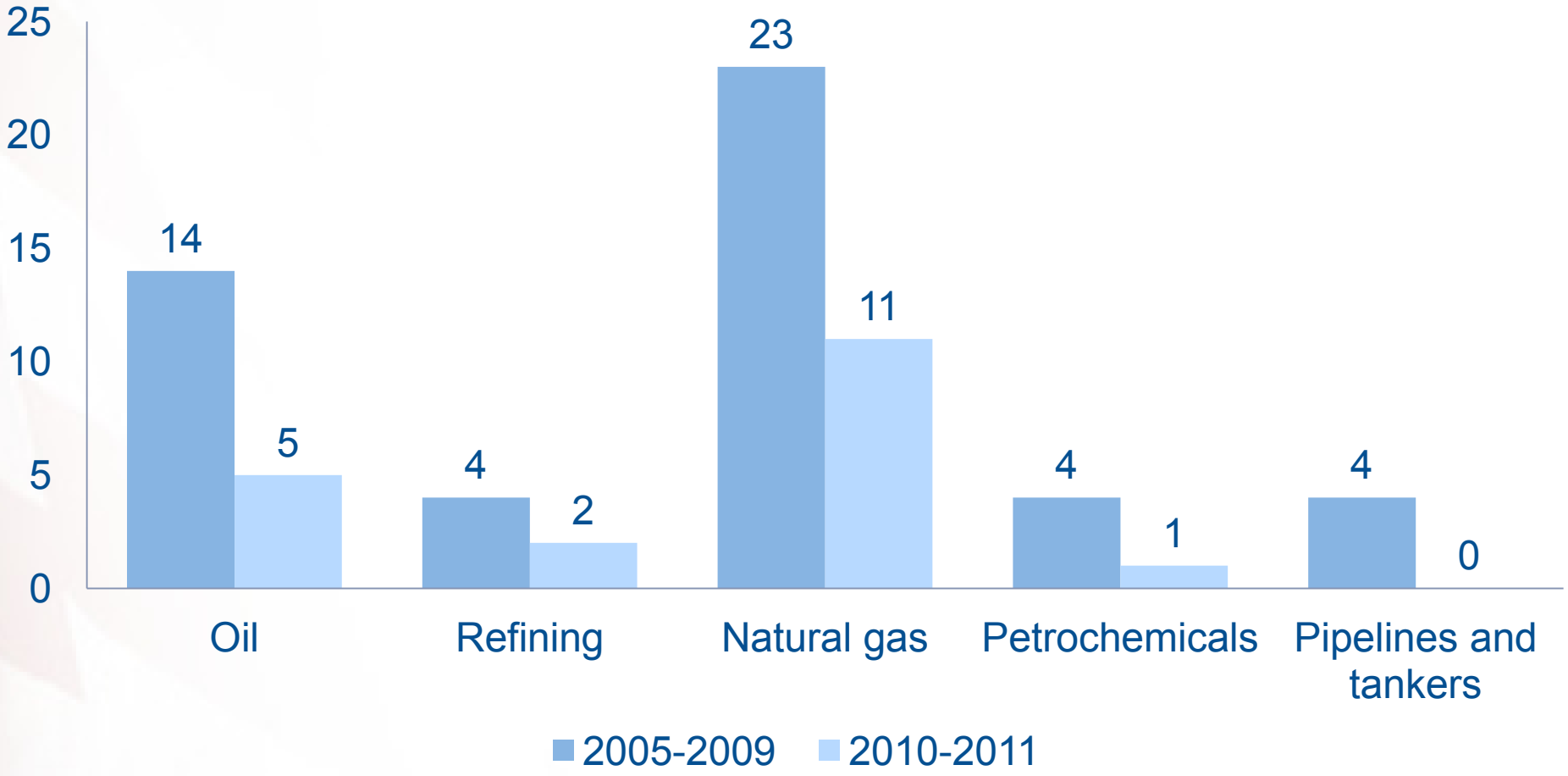
Table 2: Comparison of the Number of Firms Supporting Iran Oil and Gas Development Activities, during the Period of 2005 through 2009 and 2010 through May 2011

Activity type	Number of firms reported as having commercial activity between 2005 and 2009[a]	Number of firms reported as having commercial activity between 2010 and May 2011[a]
Oil exploration and production	14	5
Refining capacity	4	2
Natural gas	23	11
Petrochemicals	4	1
Pipelines and oil tankers	4	0

Source: GAO analysis of open source information.

[a]Multiple companies reported having commercial activity in more than one oil and gas development activity.

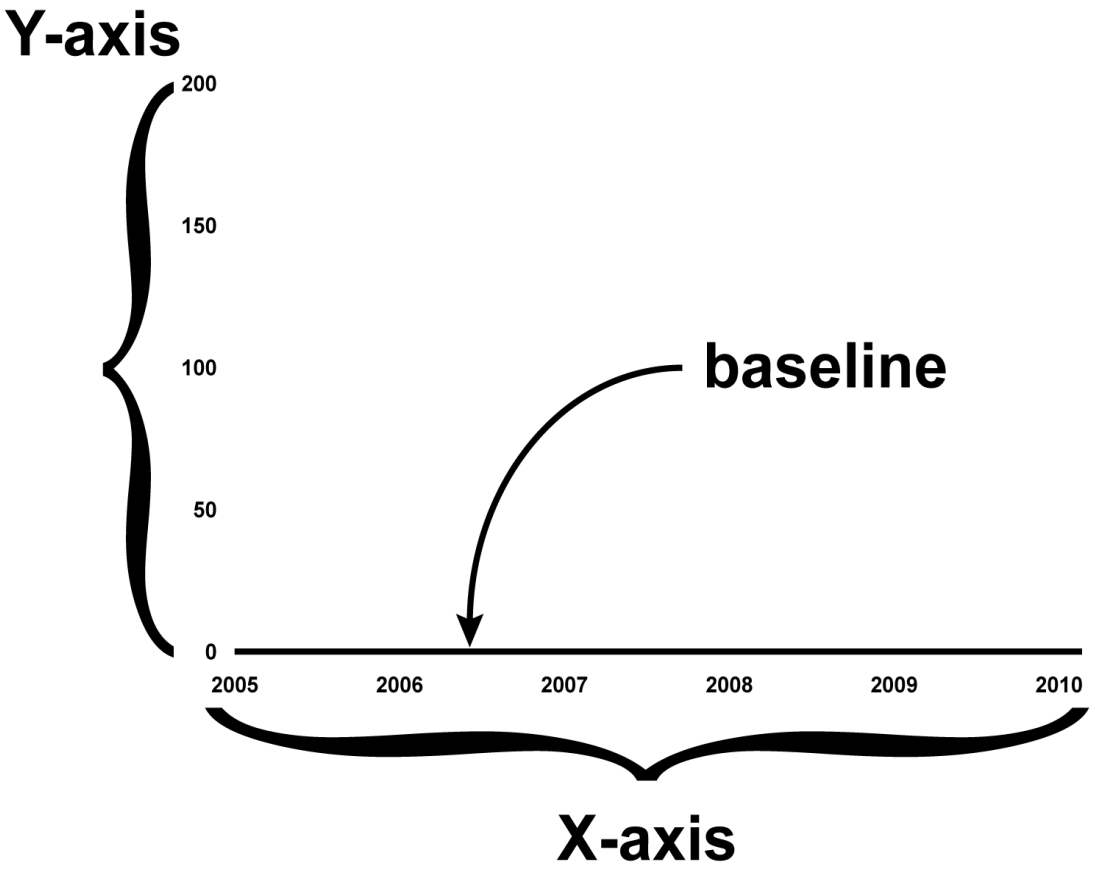
Reveal data's "story" with a chart



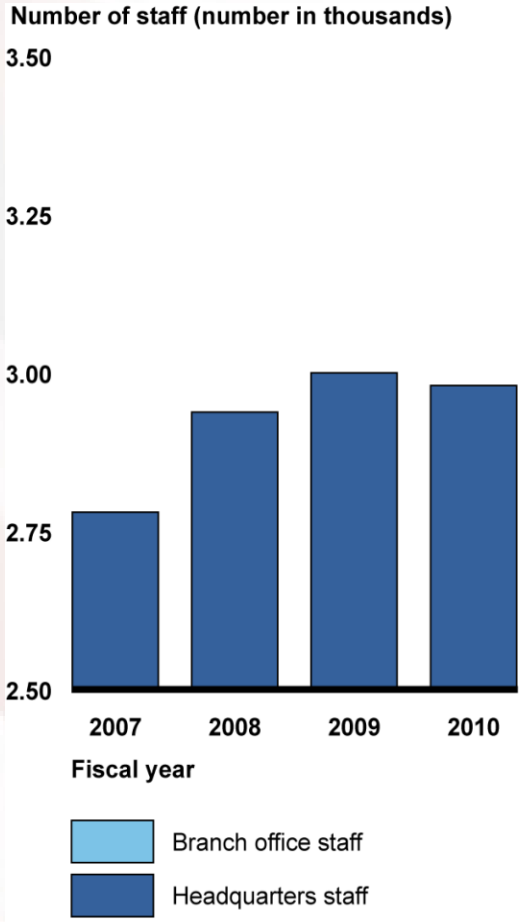
Who does what (and how)

The Five Ws and H	Graphics Options
• Who	"Bio" boxes, Organizational charts, Flow charts
• What	Tables and charts (bar, line, area, etc.); Flow charts
• When	Chronology or timeline
• Where	Map
• Why	"Combo" graphics
• How	Diagrams; Flow charts

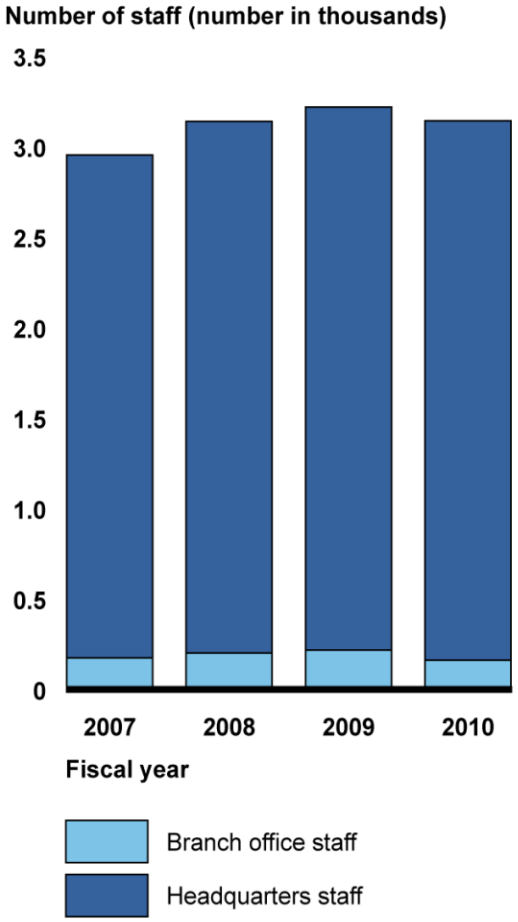
Chart Terminology



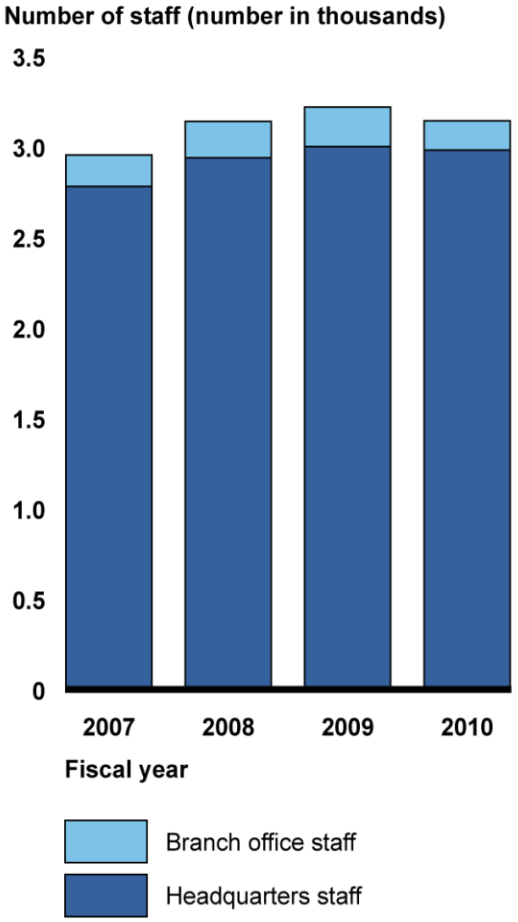
Bar charts



Source: GAO.

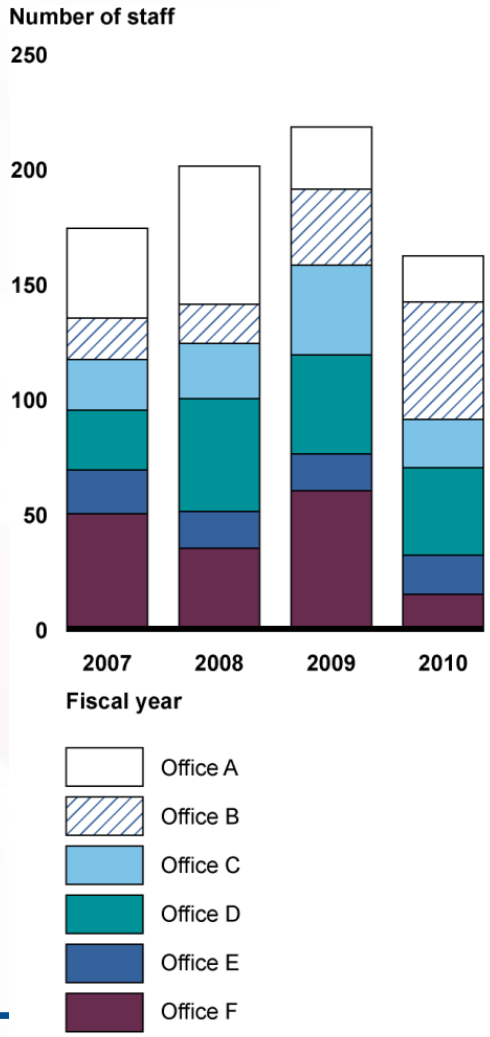


Source: GAO.

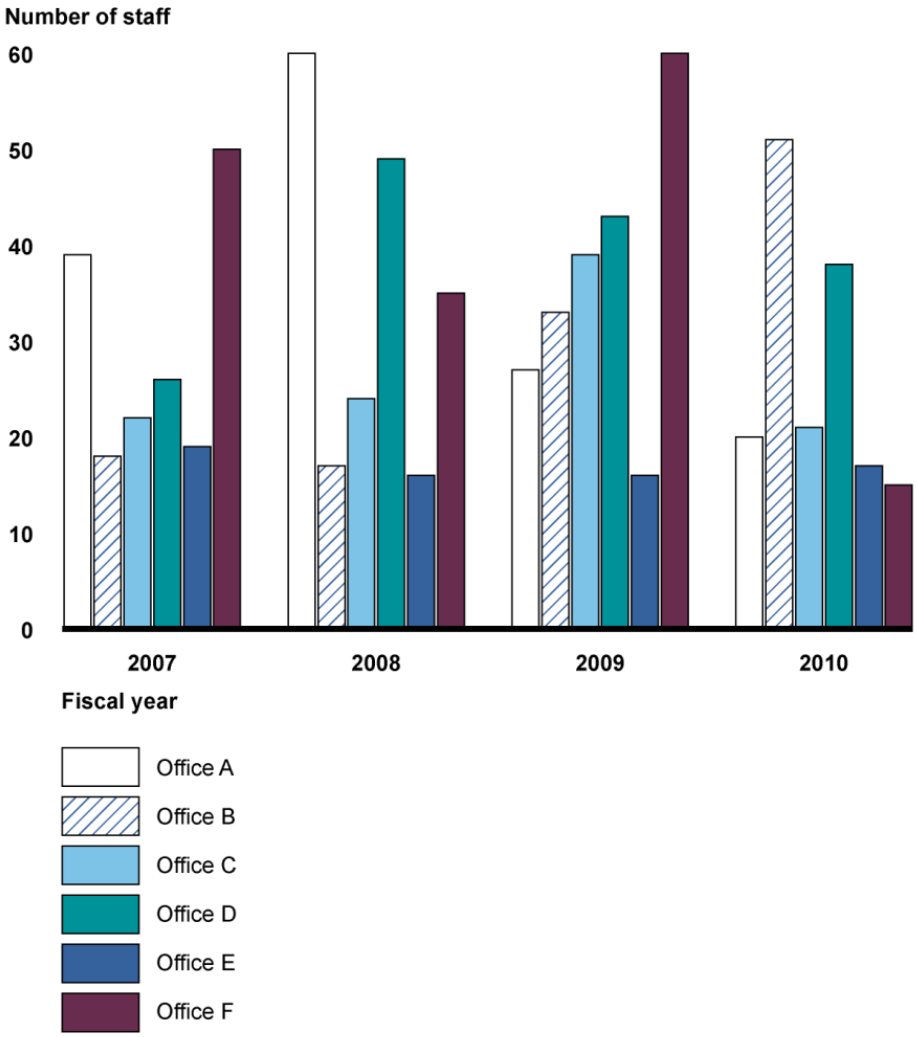


Source: GAO.

Stacked bars and Cluster bars

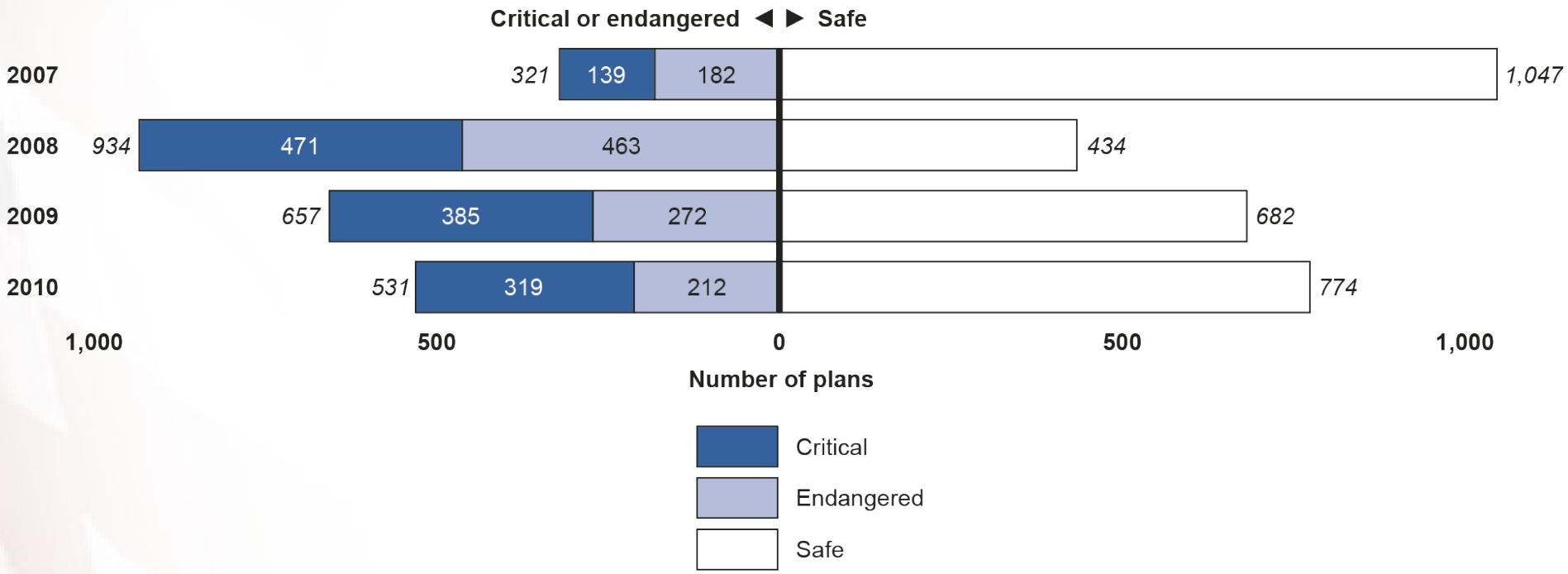


Source: GAO.



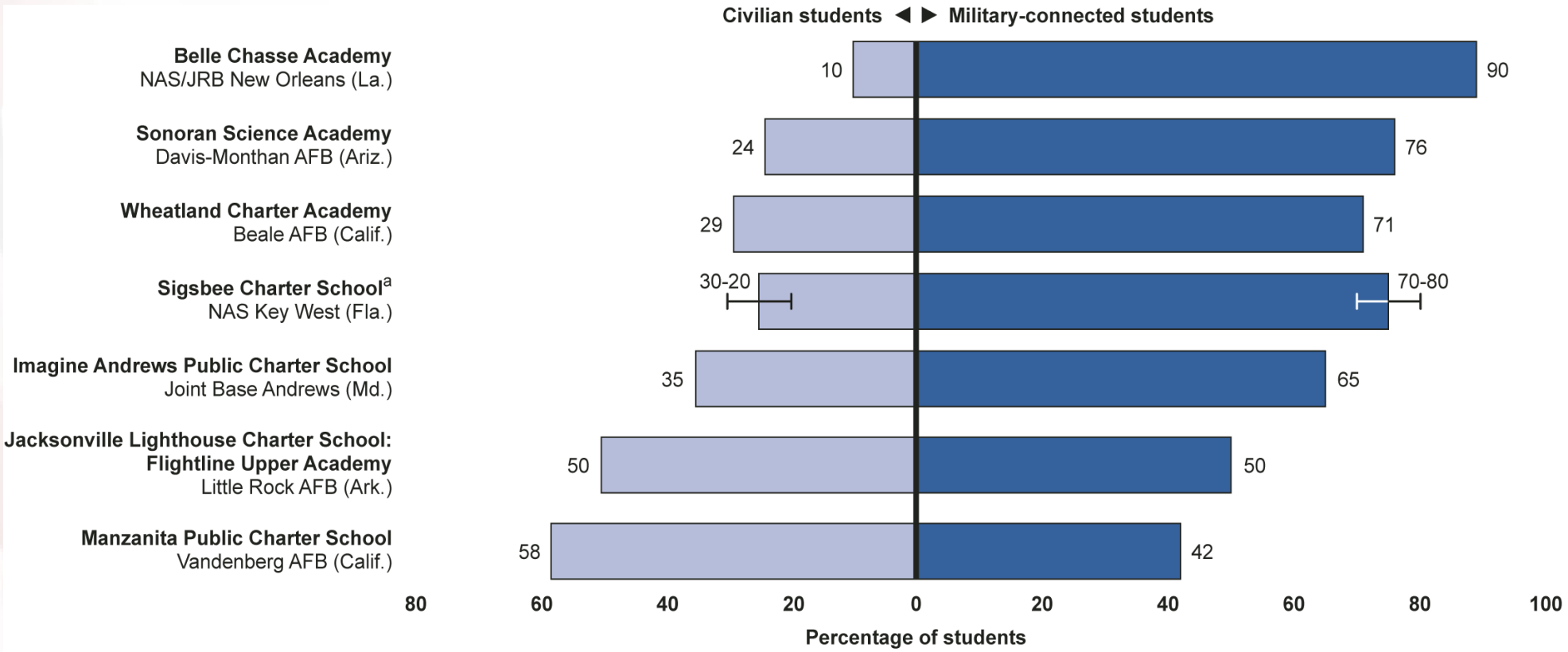
Source: GAO.

“Slidey” bars



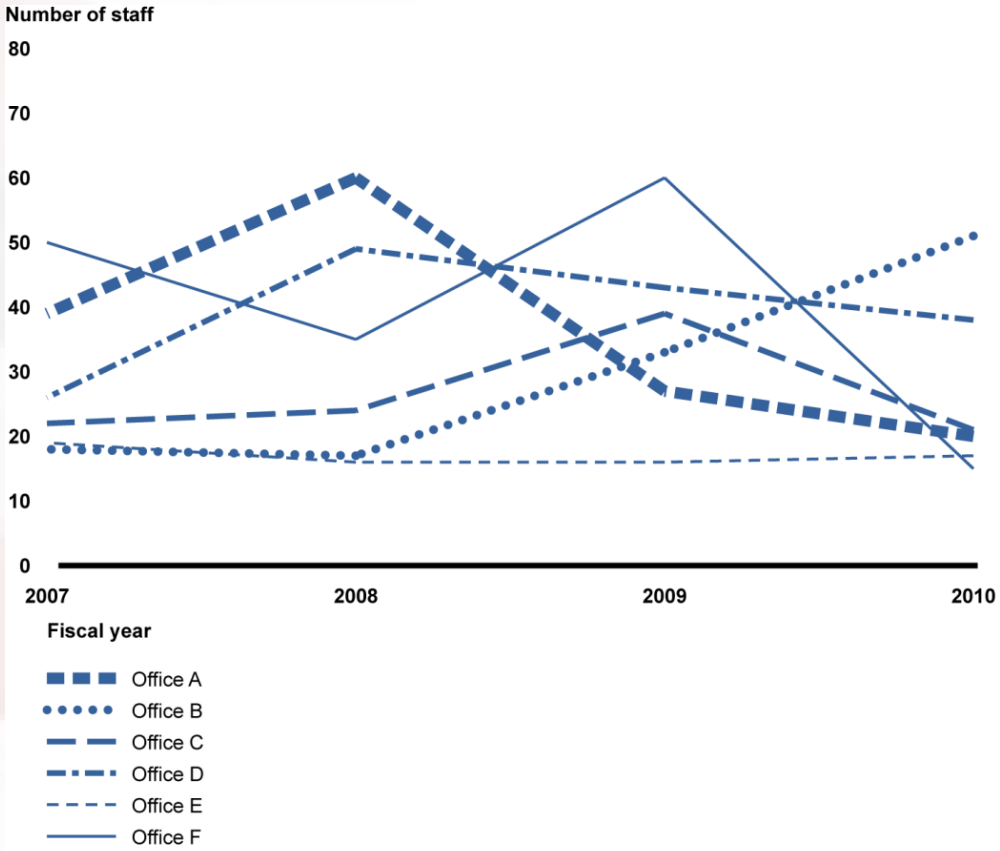
Source: GAO analysis of Internal Revenue Service annual certification data.

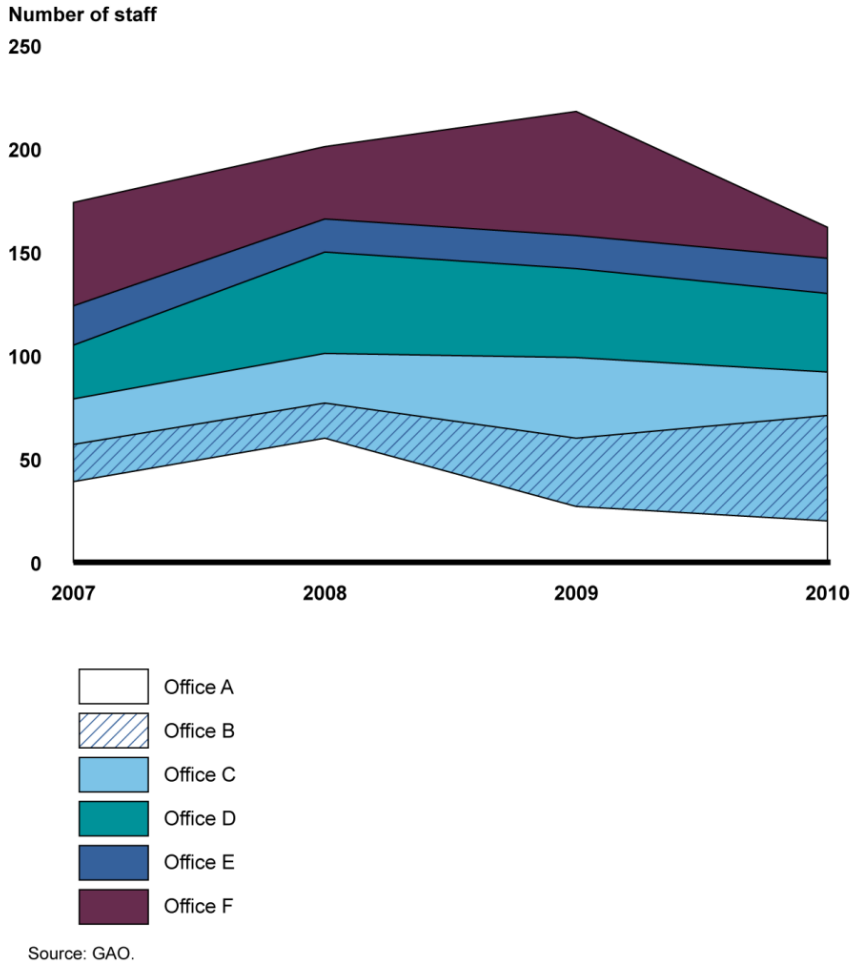
“Slidey” bars



Source: GAO analysis of school-reported data.

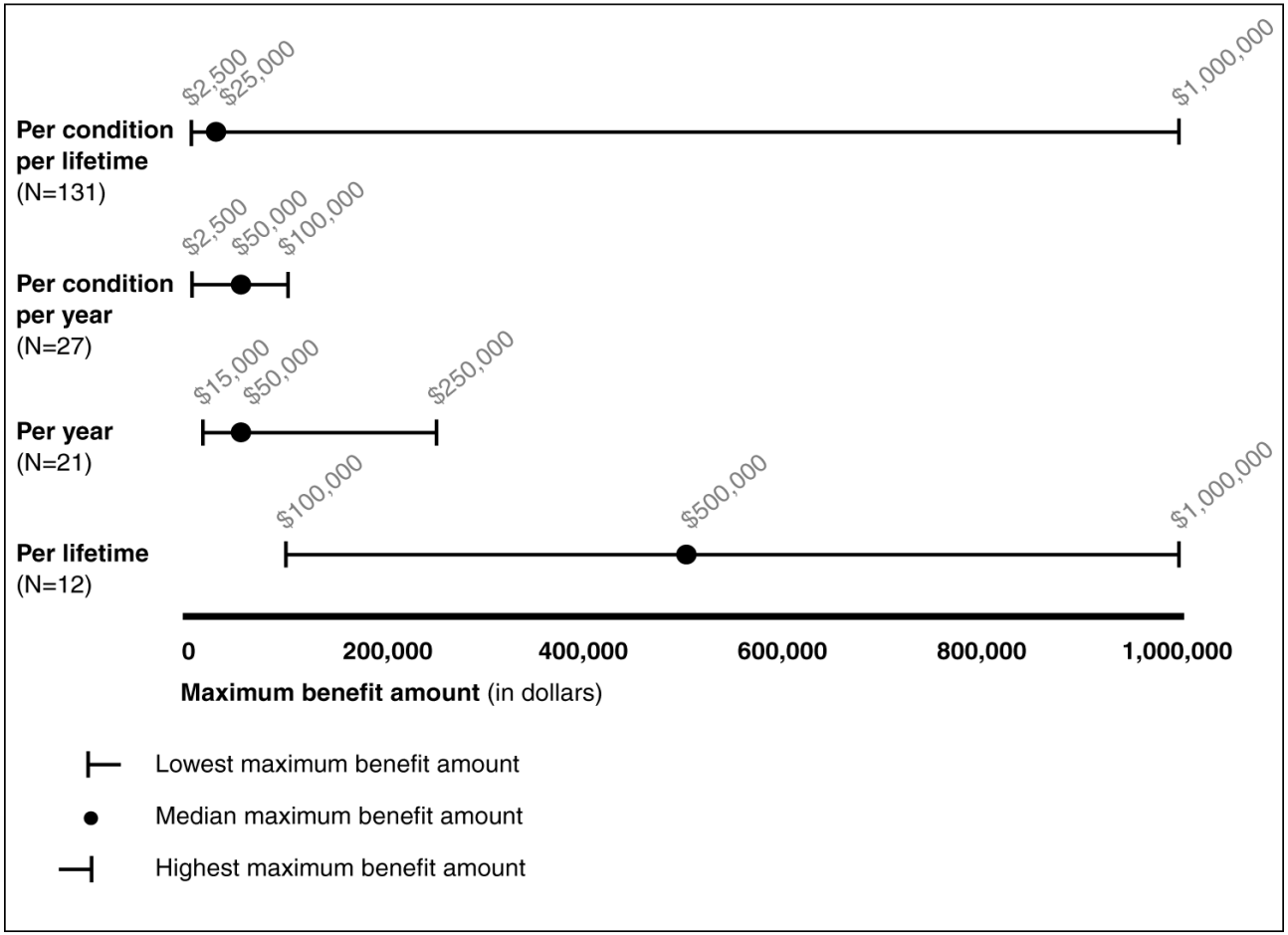
Line and area charts





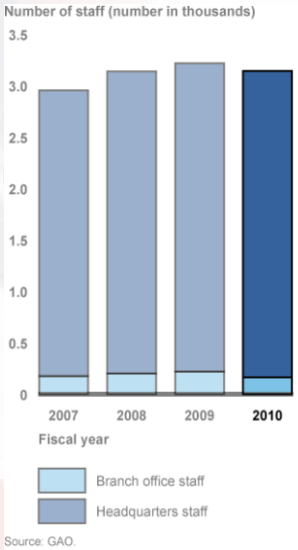
Source: GAO.

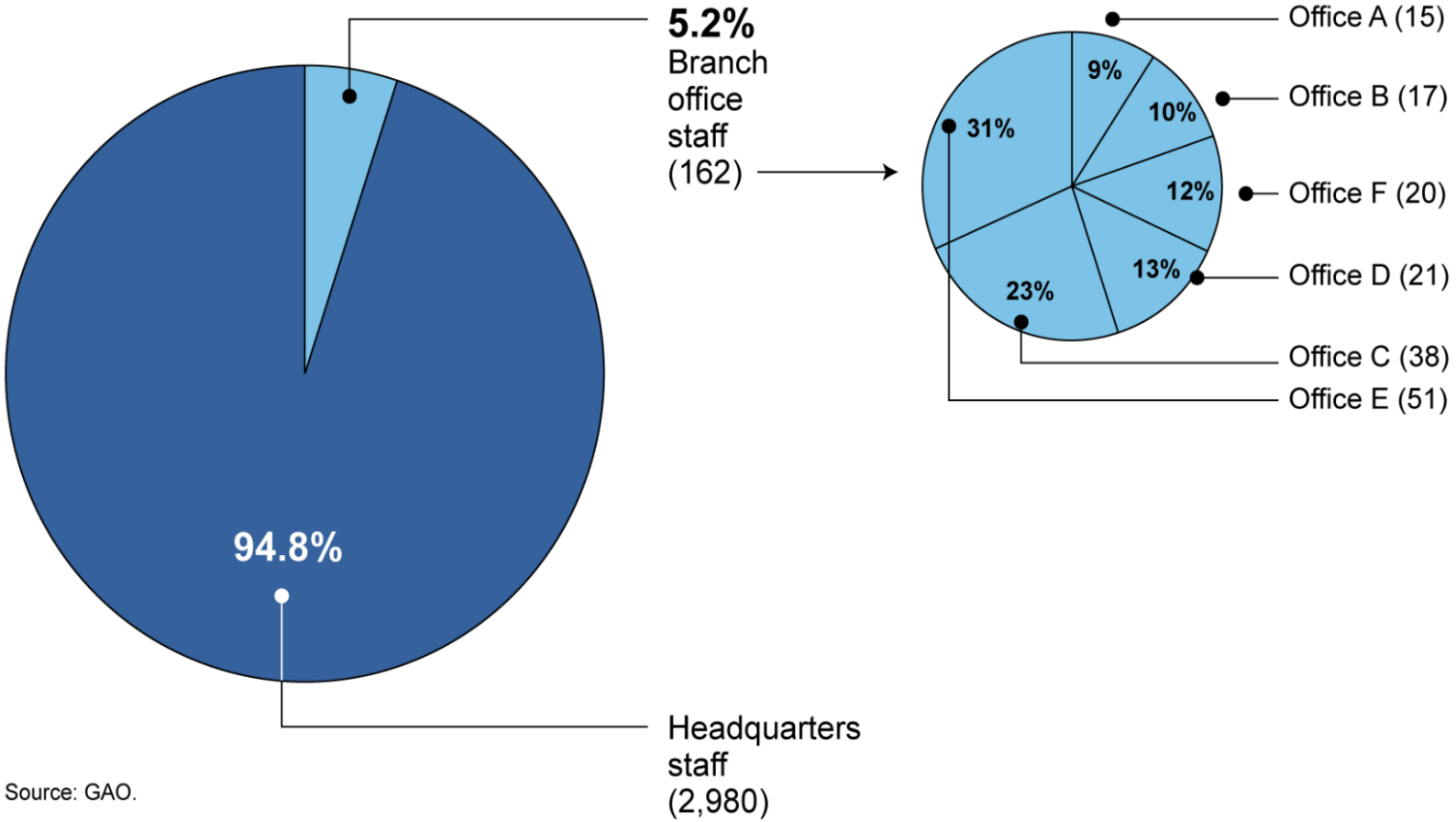
Range charts



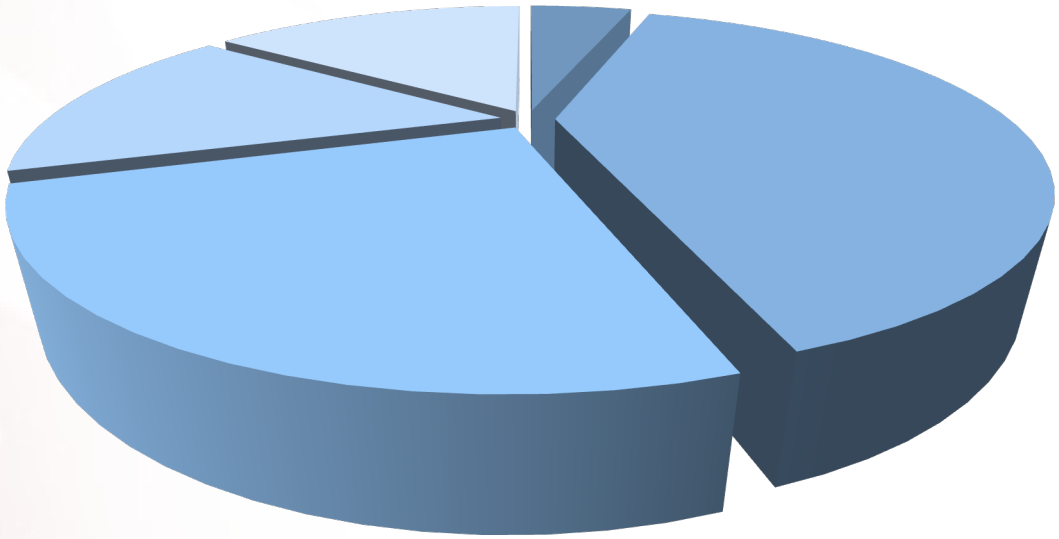
Source: GAO random sample of 340 colleges.

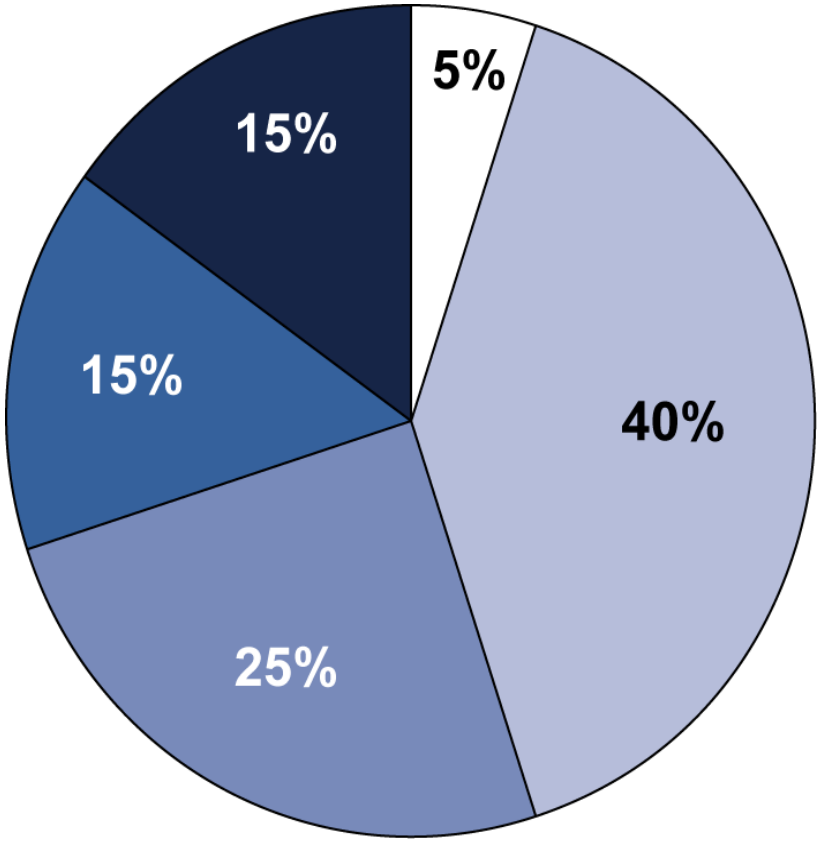
Pie charts show portions of a whole



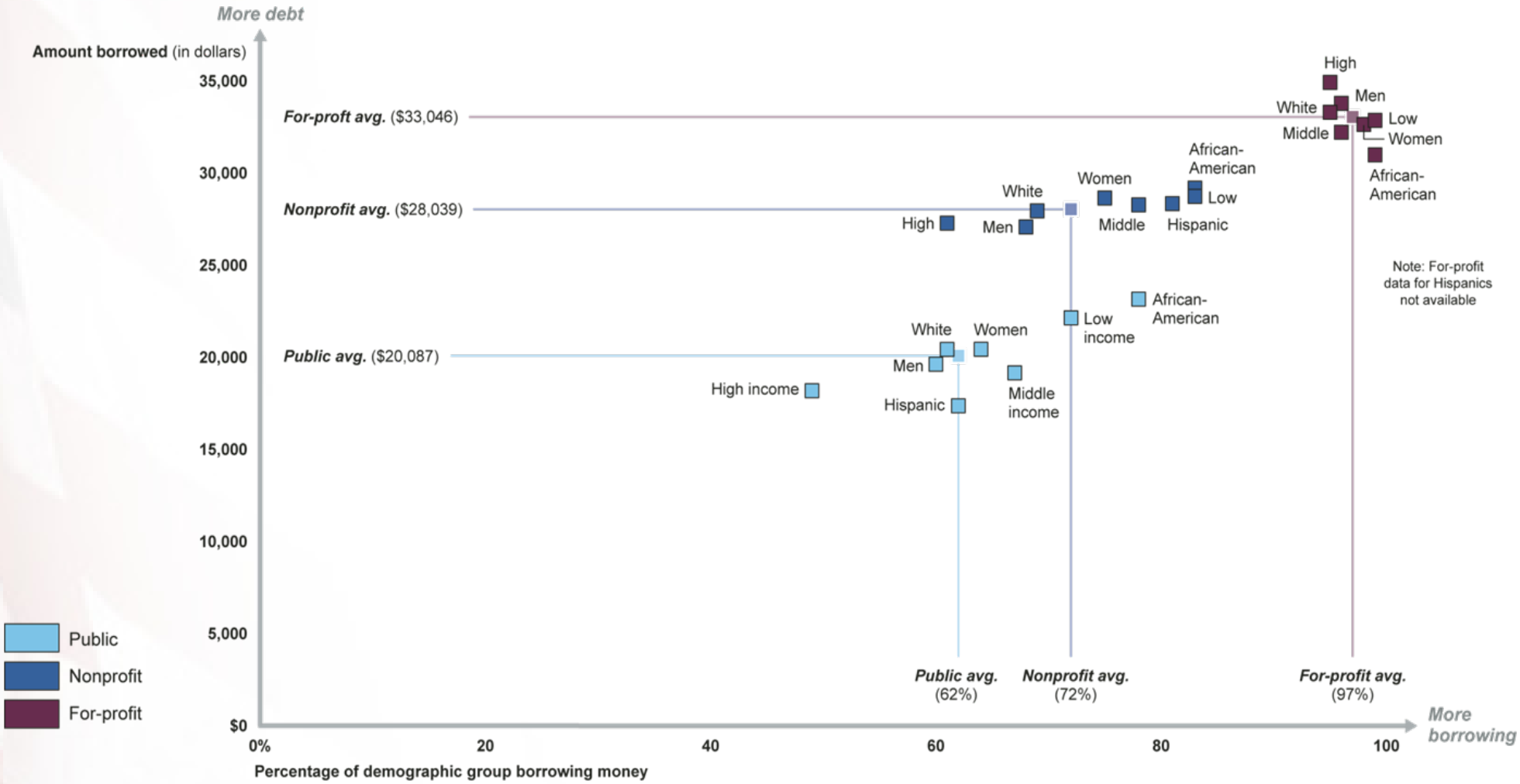


Why can’t we have those nifty 3-D charts?





Scatter charts



Matrix charts

	Australia	Canada	Finland	Germany	Sweden	Switzerland
Traditional post offices	Yes	Yes	Yes	Yes	Yes	Yes
Home delivery	Yes	Yes	Yes	Yes	Yes	Yes
Cluster boxes	No	Yes	Yes	No	Yes	Yes
24-hour automated parcel locker	No	No	No	Yes	No	No
Pick up at nonpost-owned retail counter	Yes	Yes	Yes	Yes	Yes	Yes
Digital and hybrid media	Yes	Yes	Yes	Yes	Yes	Yes

Matrix charts

Delivery options	Australia	Canada	Finland	Germany	Sweden	Switzerland
Traditional post office	✓	✓	✓	✓	✓	✓
Home delivery	✓	✓	✓	✓	✓	✓
Cluster boxes		✓	✓		✓	✓
24-hour automated parcel locker				✓		
Pick up at nonpost-owned retail counter	✓	✓	✓	✓	✓	✓
Digital and hybrid mail	✓	✓	✓	✓	✓	✓

Sources: GAO (analysis); logos used with permission from Australia Post, Canada Post, Itella, DP DHL, Posten AB, and Swiss Post.

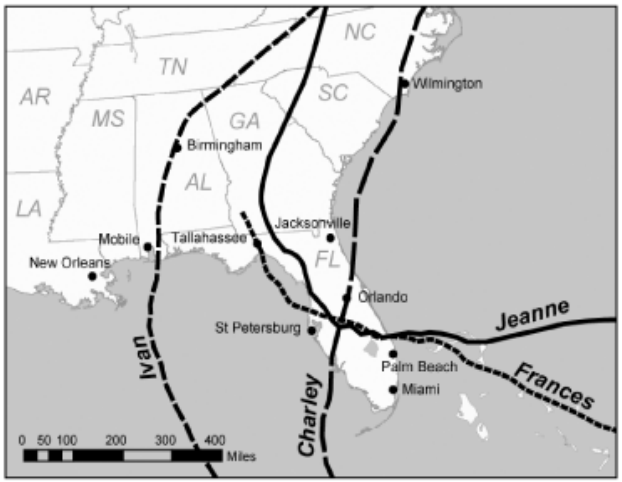
Matrix charts

	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	Forces reported offering
	Enhanced benefits		*Enhanced benefits*			*Enhanced benefits*	*Enhanced benefits*				
Recruiting/Retention											
Superior qualifications[a]	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	4
Retention bonus	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	2
Recruiting bonus	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	1
Relocation/Classification											
Specialized unit opportunity[b]	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	9
Relocation bonus	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	1
Incentives/Awards											
Performance bonus (cash)	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	9
Performance bonus (non-cash)	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	7
Referral bonus	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	none
Training/Development											
External training payment/reimbursment	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	6
Increased pay after basic training is completed	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	2
Waiver of requirement(s)[c]	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	2
Work/Life balance											
Gym/fitness program	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	9
Transportation subsidy	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	8
Tuition assistance	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	6
Student loan repayment	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	4
Take home vehicle	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	4
Alternative work schedule[d]	USCP	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	4
Child care program	USCP[e]	NIH	Sec. Srv.	Pent.	BEP	Sup. Crt.	Park	FBI	FEMA	Postal	3
Flexibilites offered	8	13	12	10	9	8	7	7	4	3	

Offered Available but not offered Neither available nor offered

Source: Analysis of GAO 2011 survey of select federal police forces.

Super matrix (combo graphics)

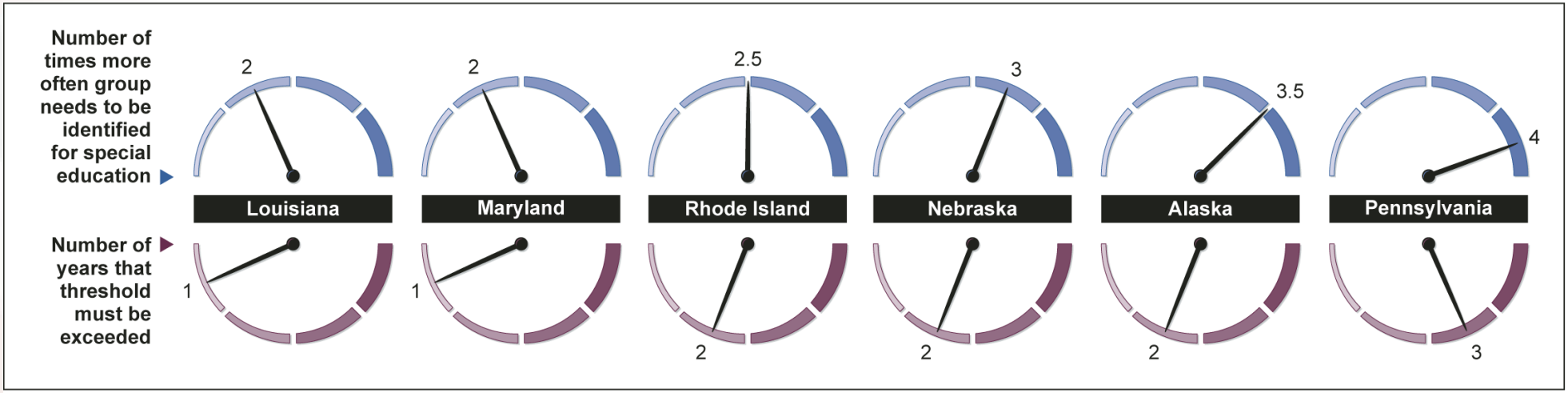


Four hurricanes made landfall in the United States within a 6-week period in 2004. The storms caused an estimated $27 billion in insured losses in the United States and the Caribbean. As a whole, the 2004 hurricane season is the second most expensive insurance event in U.S. history, behind the September 11, 2001, terrorist attacks. The chart below details the impact of the four storms on Florida.

	Date of landfall	Saffir-Simpson Hurricane Scale	Estimated insured losses (in billions)	Number of claims reported (in thousands)
Charley	13 Aug. – Sept.	1 2 3 **4** 5	$7.885	449
Frances	5 Aug. – Sept.	1 **2** 3 4 5	4.801	504
Ivan	16 Aug. – Sept.	1 2 **3** 4 5	3.914	197
Jeanne	25 Aug. – Sept.	1 2 **3** 4 5	4.153	393

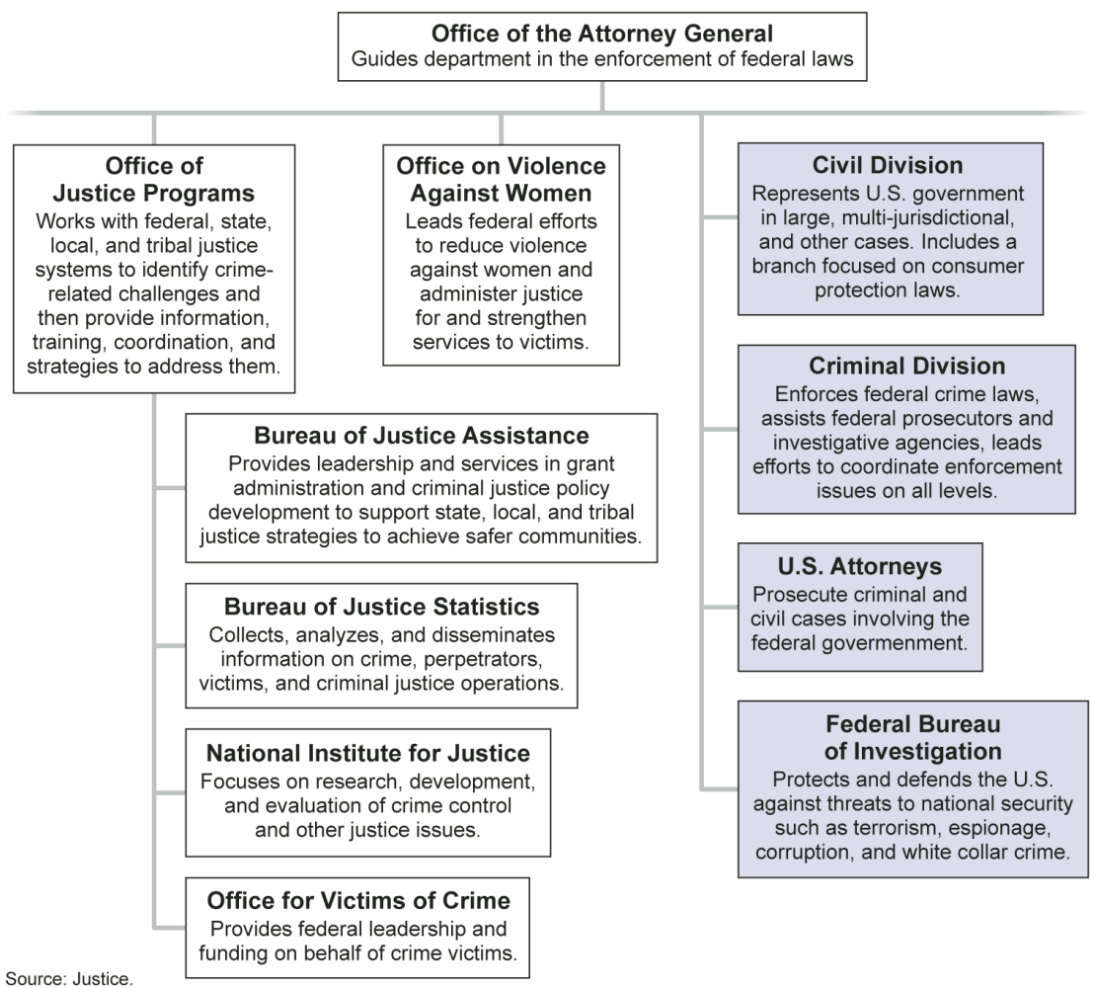
Sources: Benfield Group Limited, Florida Insurance Council, Florida Office of Insurance Regulation, Guy Carpenter, Swiss Re, and Risk Management Solutions (map).

“Dashboard” charts



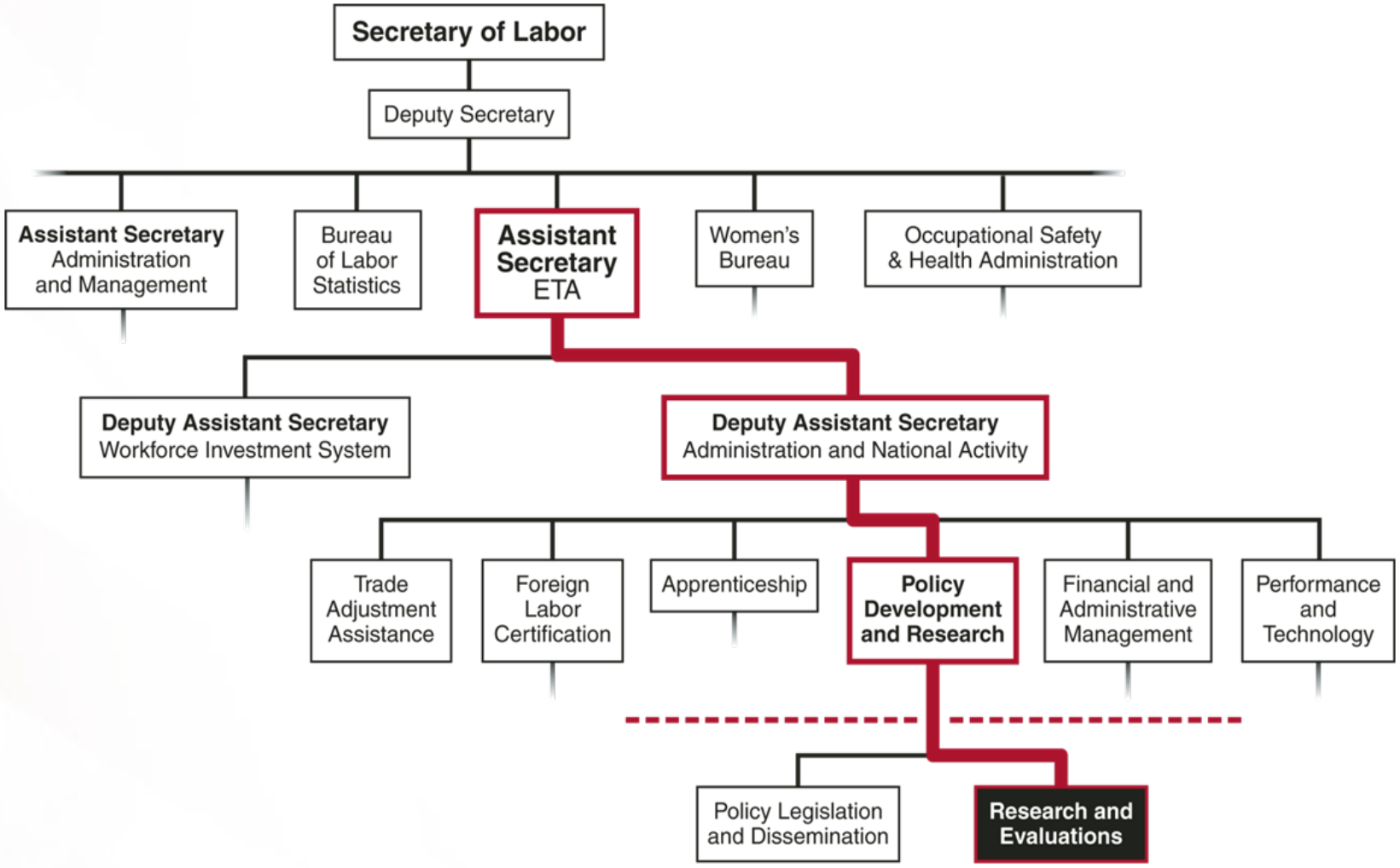
Source: GAO analysis of selected states’ definitions of significant disproportionality.

Organizational charts

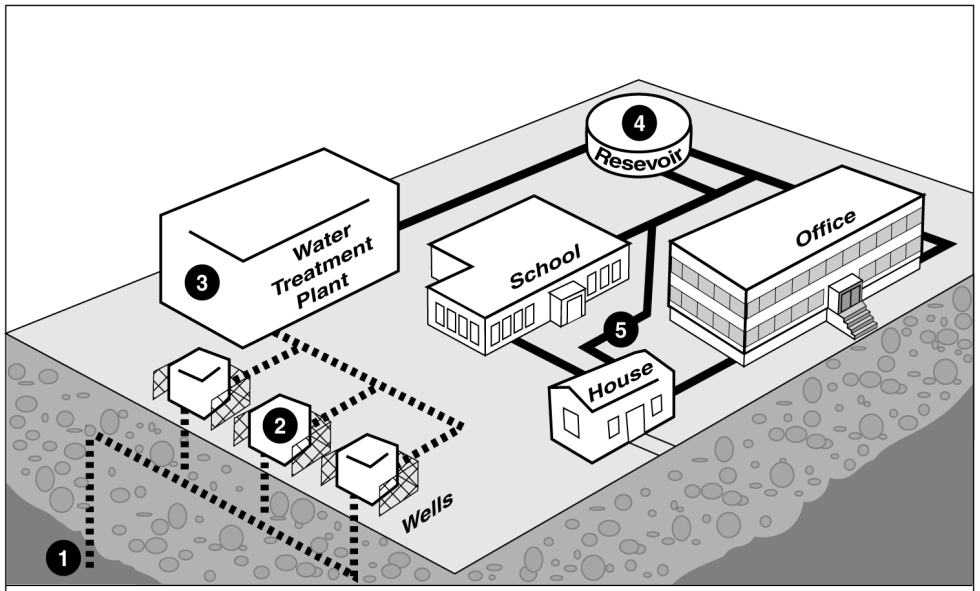


Source: Justice.

Organizational charts



Diagrams



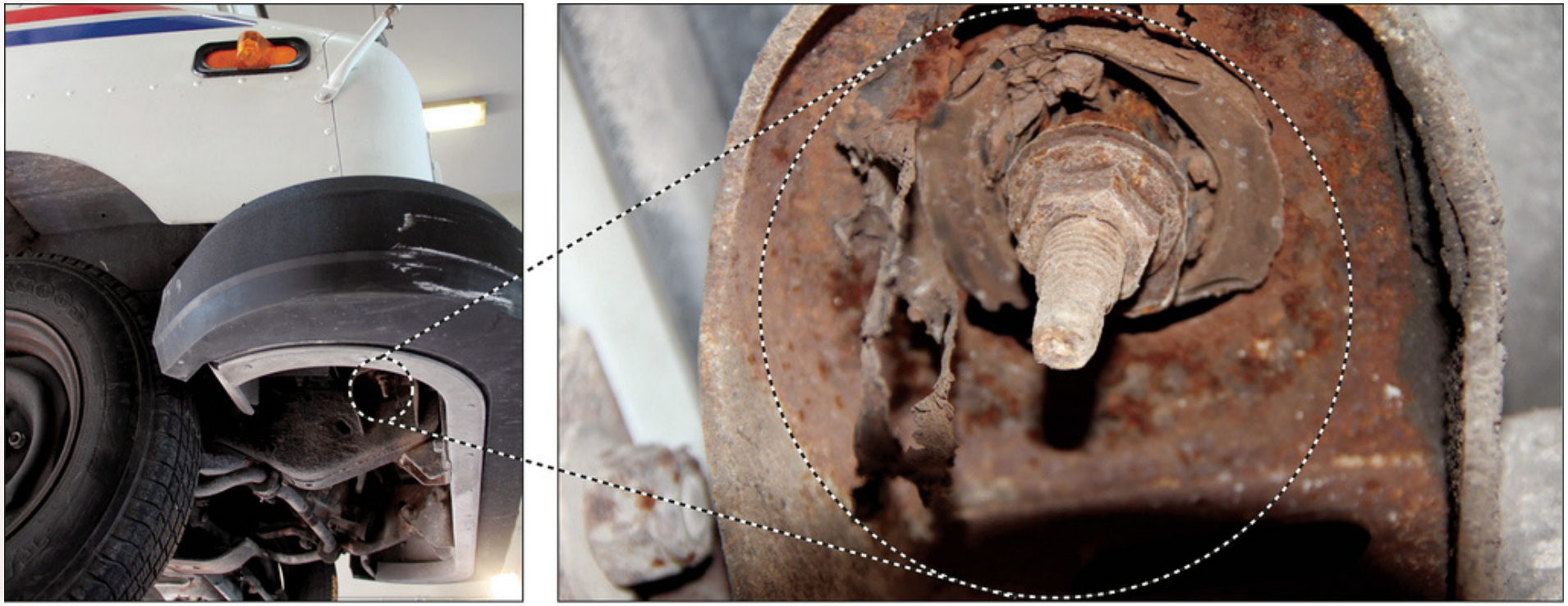
1 The drinking water at Camp Lejeune is obtained from groundwater pumped from a freshwater aquifer located approximately 180 feet below the ground. 2 Groundwater is pumped through wells located near the water treatment plant. 3 In the water treatment plant, the untreated water is mixed and treated through several processes: removal of minerals to soften the water, filtration through layers of sand and carbon to remove particles, chlorination to protect against microbial contamination, and fluoride addition to help prevent tooth decay. 4 After the water is treated, it is stored in reservoirs and elevated storage tanks. 5 When needed, treated water is pumped from the reservoirs and tanks to facilities such as offices, schools, or houses on the base.

Untreated water

Treated water

Source: GAO, Art Explosion, and Marine Corps Base Camp Lejeune.

Photos (and video)



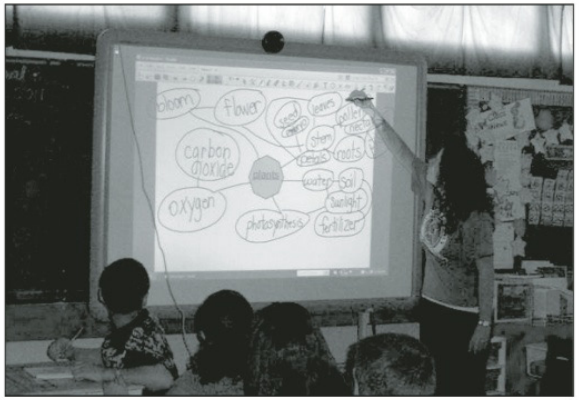
Source: GAO.

Photo groupings

Summer school students use a computer lab in a Water Valley elementary school.

A display showing images from security cameras around an East Tallahatchie school. The remote security system allows the school's administrators to view live video directly from their desktop computers.

A classroom in Fairfield-Suisun to help students with cognitive disabilities and significant behavorial issues learn life skills, such as cooking and cleaning.

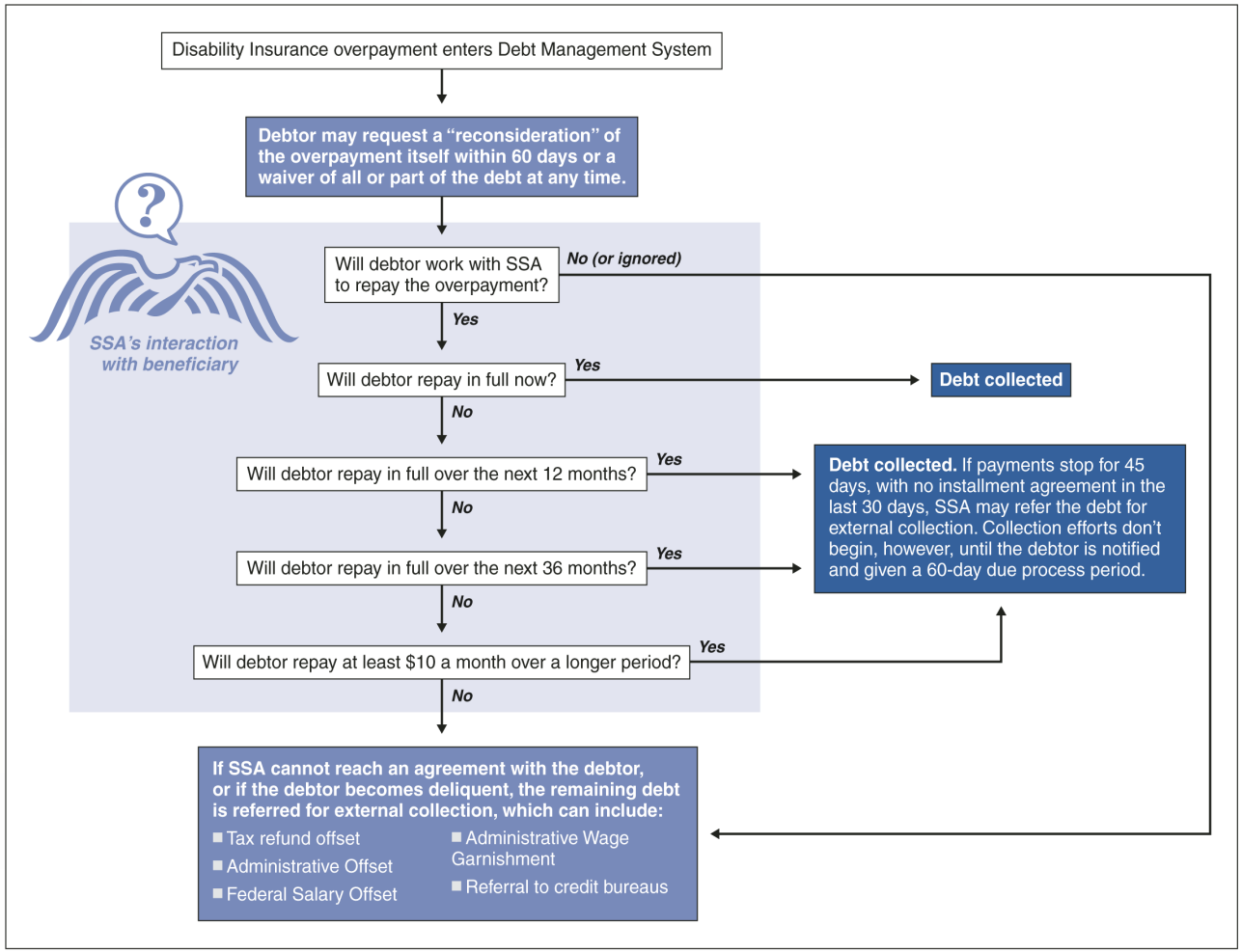


Above: A New Bedford teacher using a Smart Board.

Left: A "Sensory Room" designed to aid the physical and cognitive development of special needs students in New Bedford.

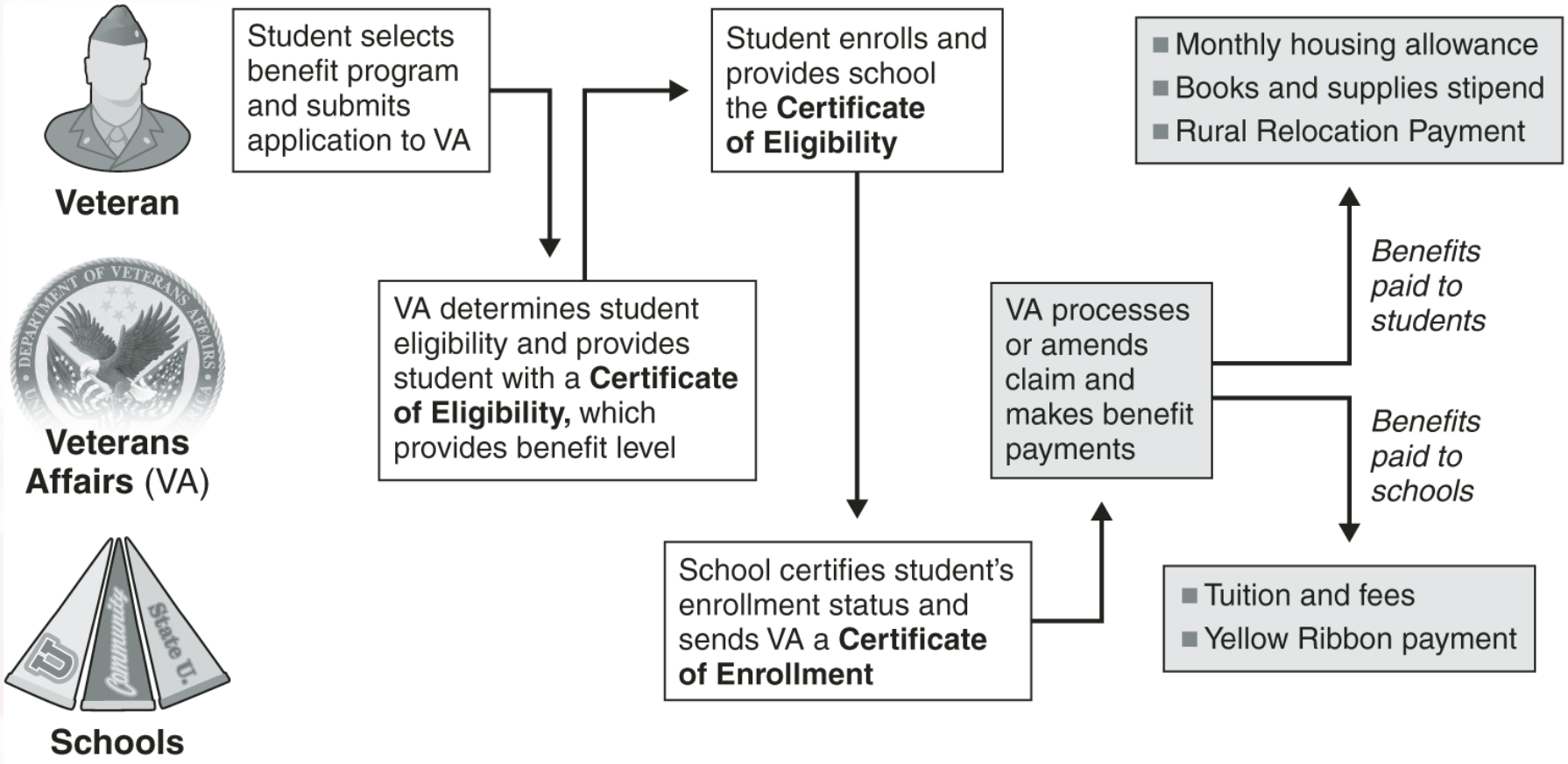
Source: GAO.

Flowcharts



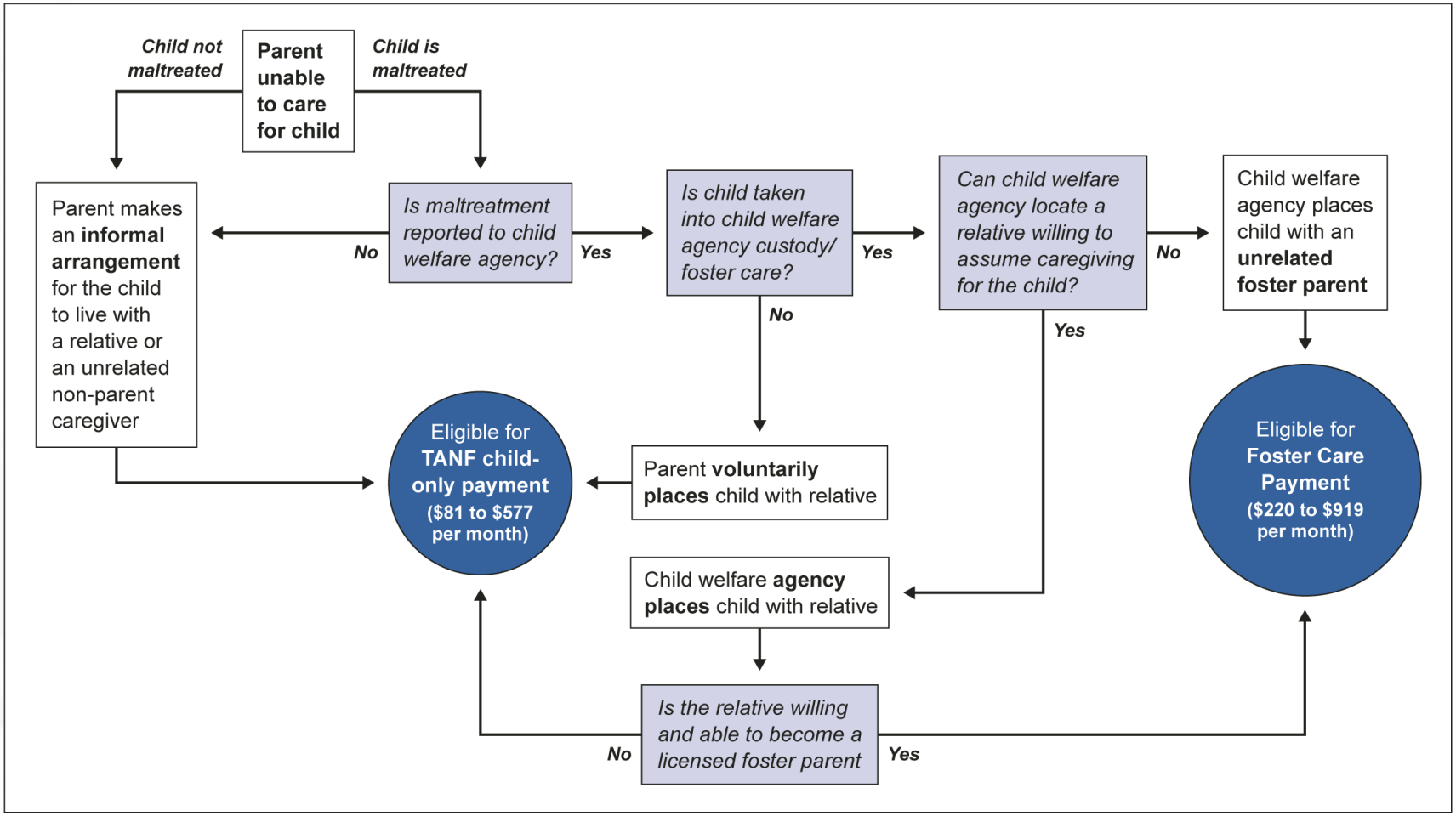
Source: GAO analysis of SSA policies.

Flowcharts



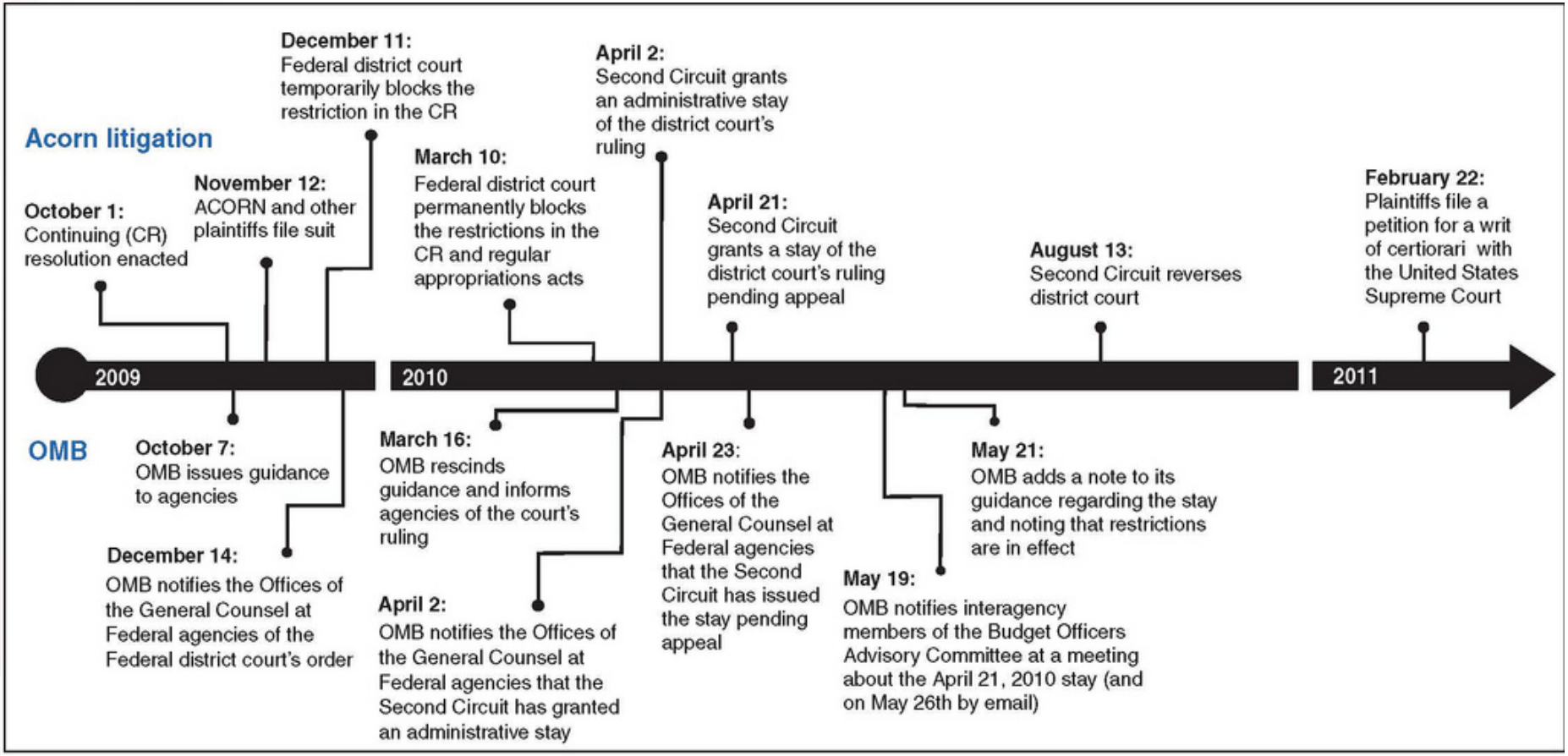
Source: GAO analysis of VA documents; GAO (images).

Flowcharts



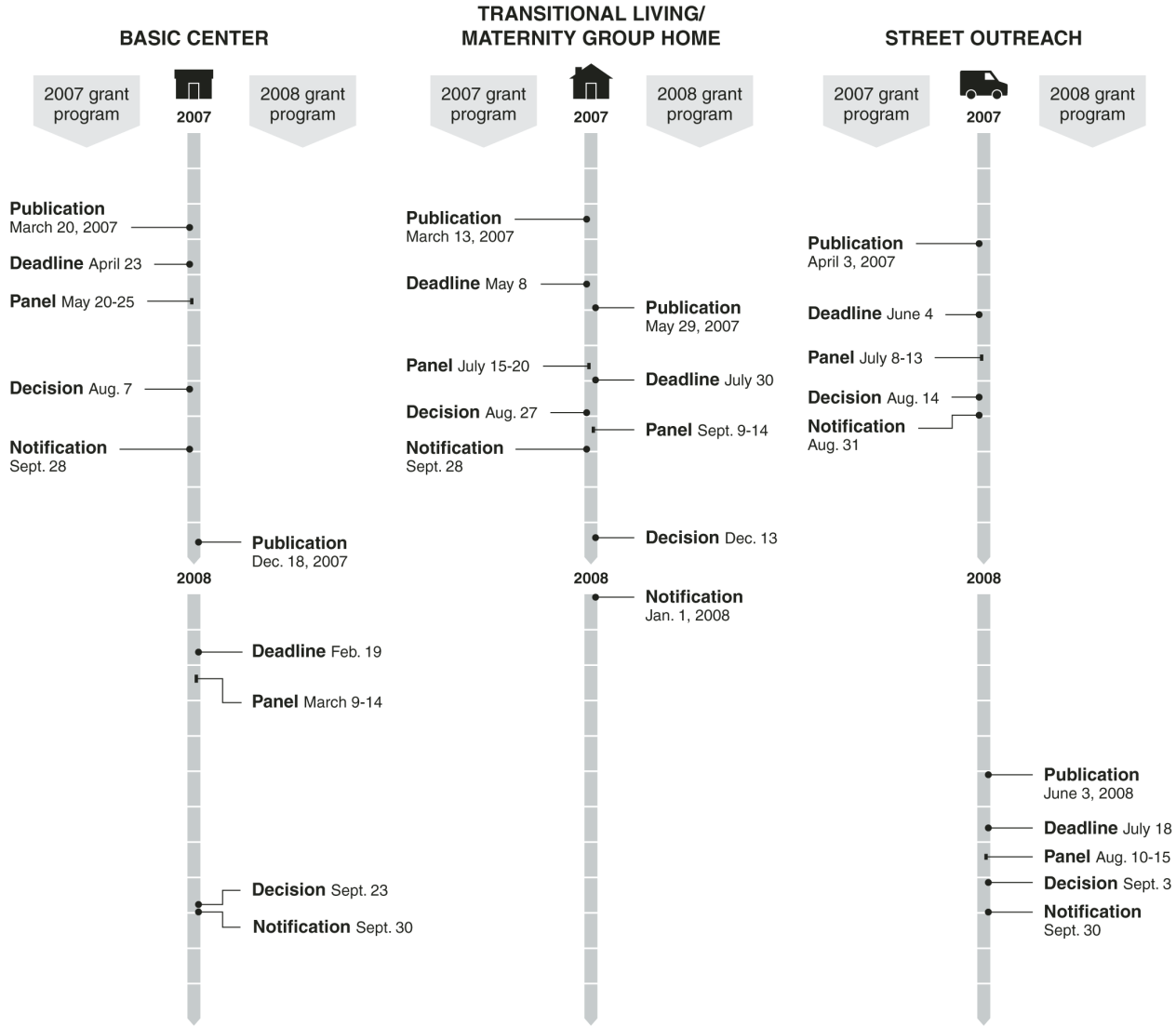
Source: GAO analysis of related studies and GAO survey results.

Timelines (when necessary)



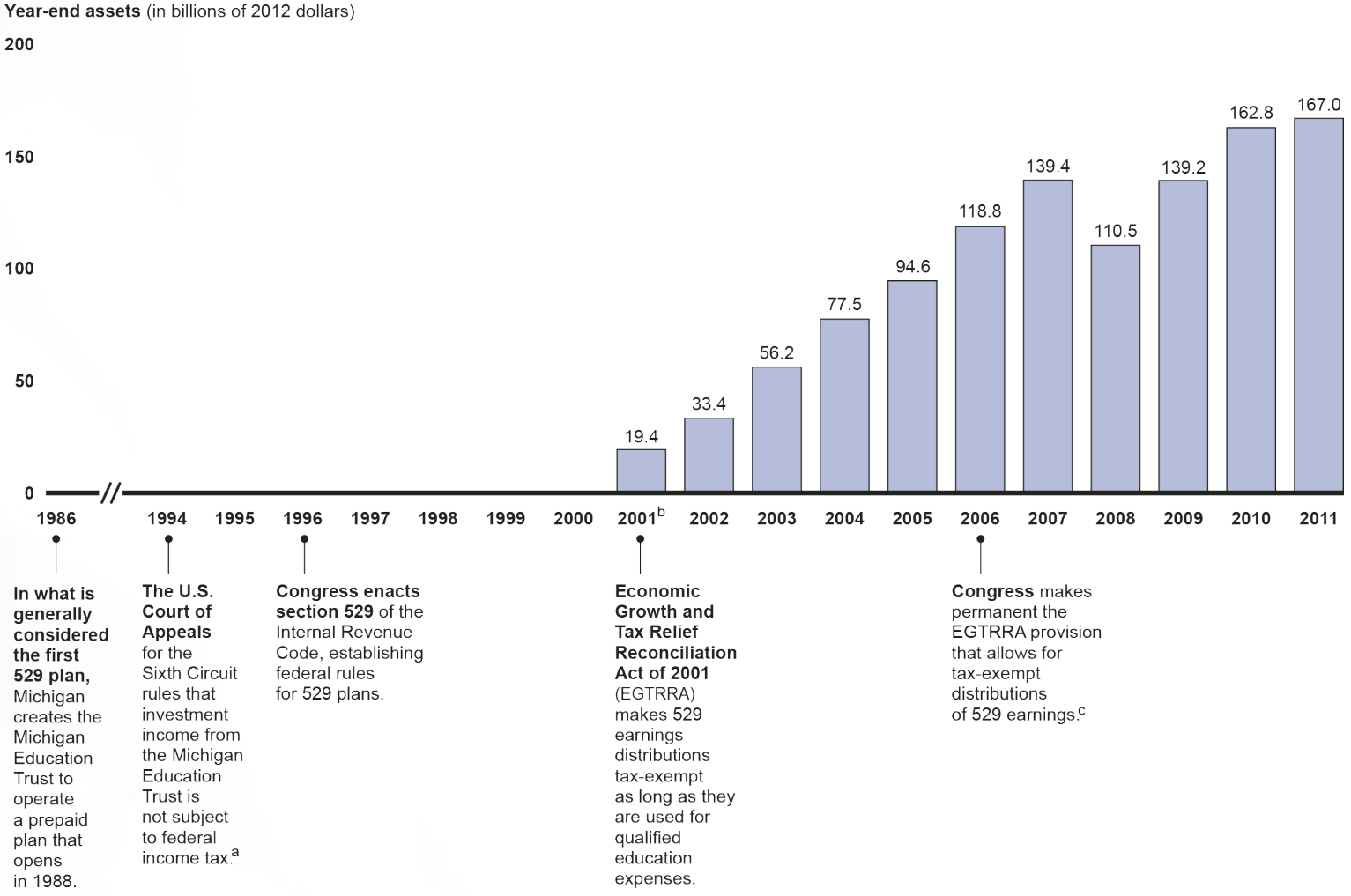
Source: GAO analysis of court and OMB documents.

Timelines


BASIC CENTER
2007 grant program
2007
2008 grant program
Publication March 20, 2007
Deadline April 23
Panel May 20-25
Decision Aug. 7
Notification Sept. 28
Publication Dec. 18, 2007
2008
Deadline Feb. 19
Panel March 9-14
Decision Sept. 23
Notification Sept. 30
TRANSITIONAL LIVING/ MATERNITY GROUP HOME
2007 grant program
2007
2008 grant program
Publication March 13, 2007
Deadline May 8
Publication May 29, 2007
Panel July 15-20
Deadline July 30
Decision Aug. 27
Panel Sept. 9-14
Notification Sept. 28
Decision Dec. 13
2008
Notification Jan. 1, 2008
STREET OUTREACH
2007 grant program
2007
2008 grant program
Publication April 3, 2007
Deadline June 4
Panel July 8-13
Decision Aug. 14
Notification Aug. 31
2008
Publication June 3, 2008
Deadline July 18
Panel Aug. 10-15
Decision Sept. 3
Notification Sept. 30

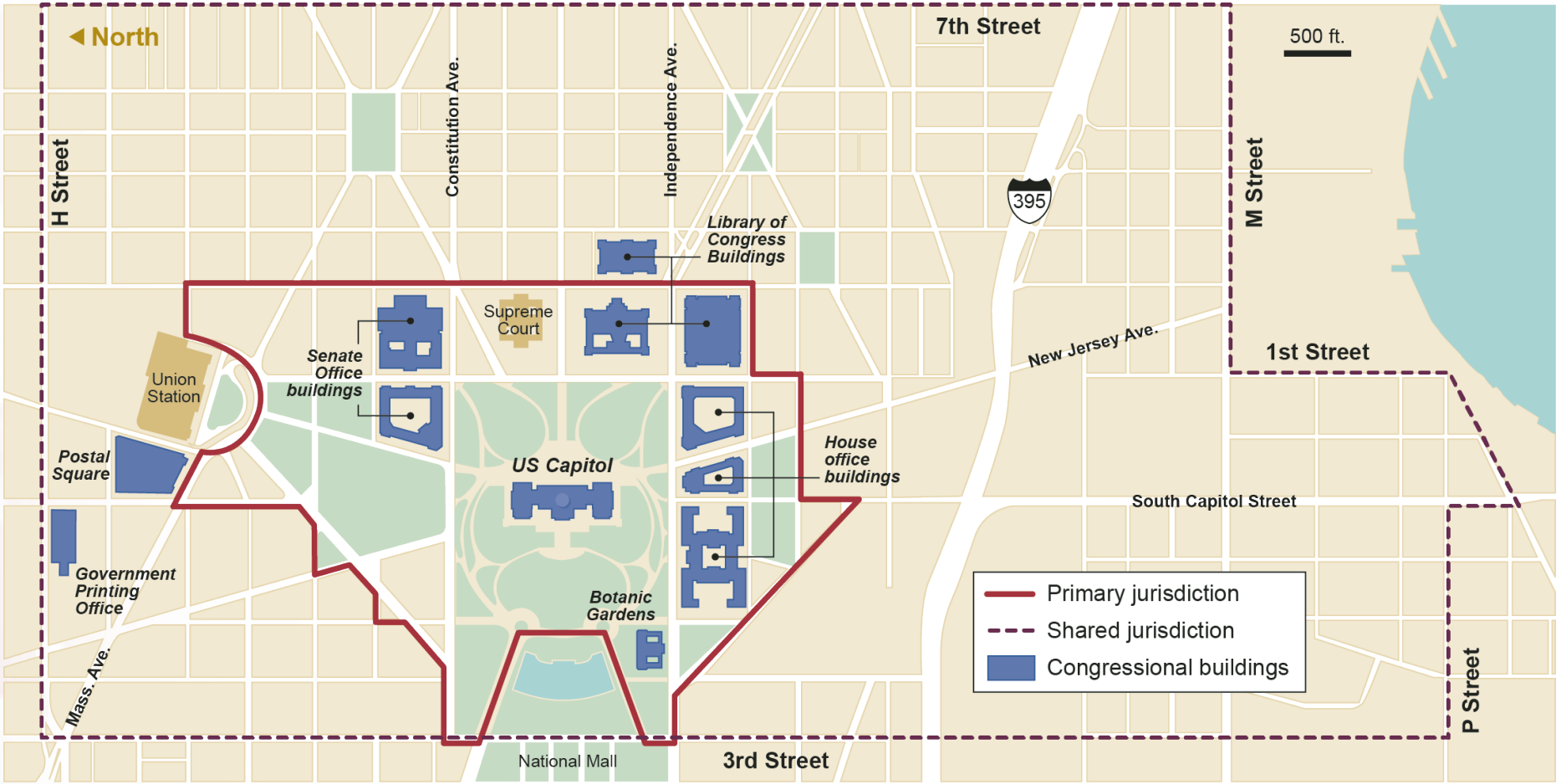
Free timelines*

*when you buy a chart of equal value



Source: GAO analysis of Financial Research Corporation data and relevant legislation.

Maps show boundaries

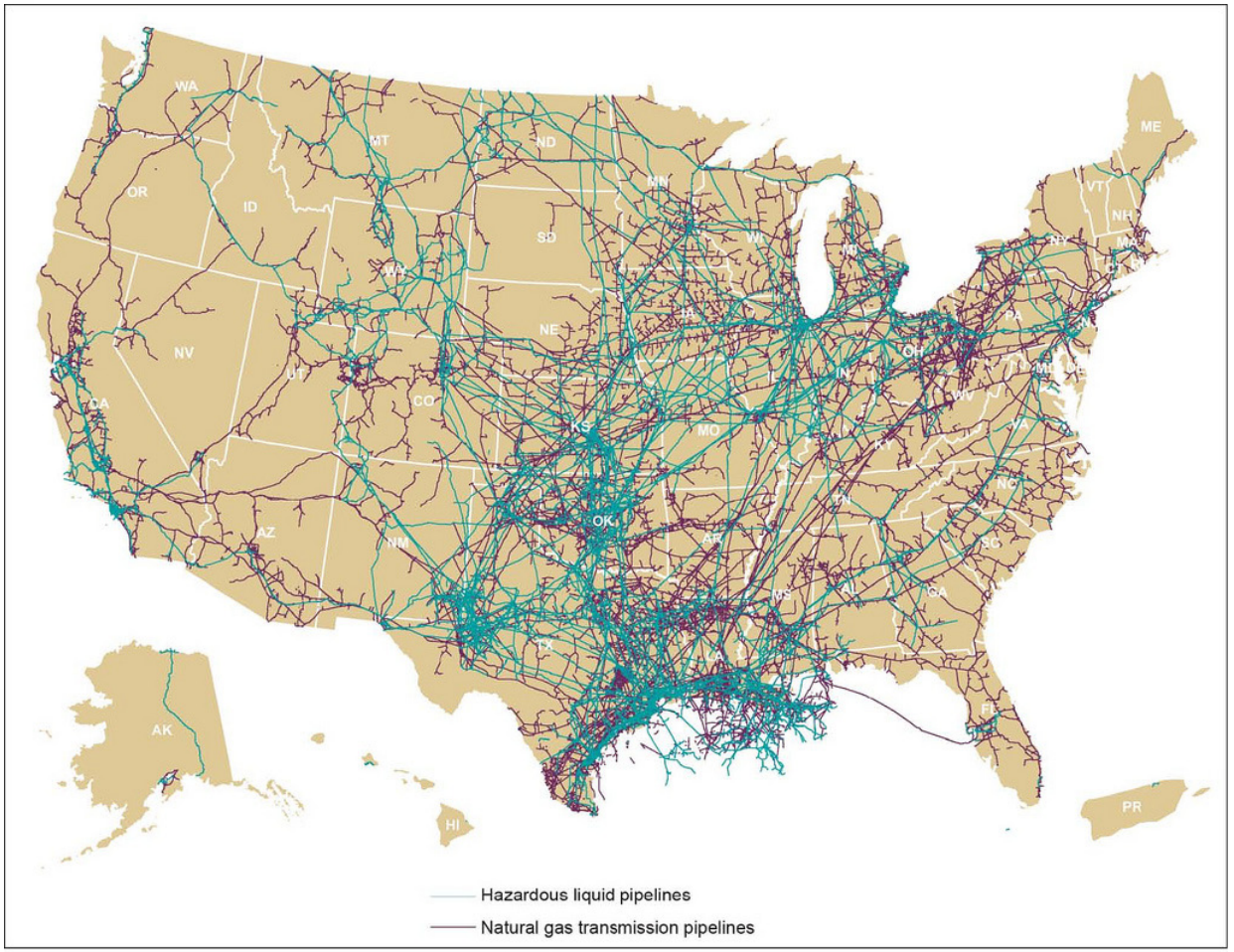


Source: USCP.

Maps locate places and landmarks

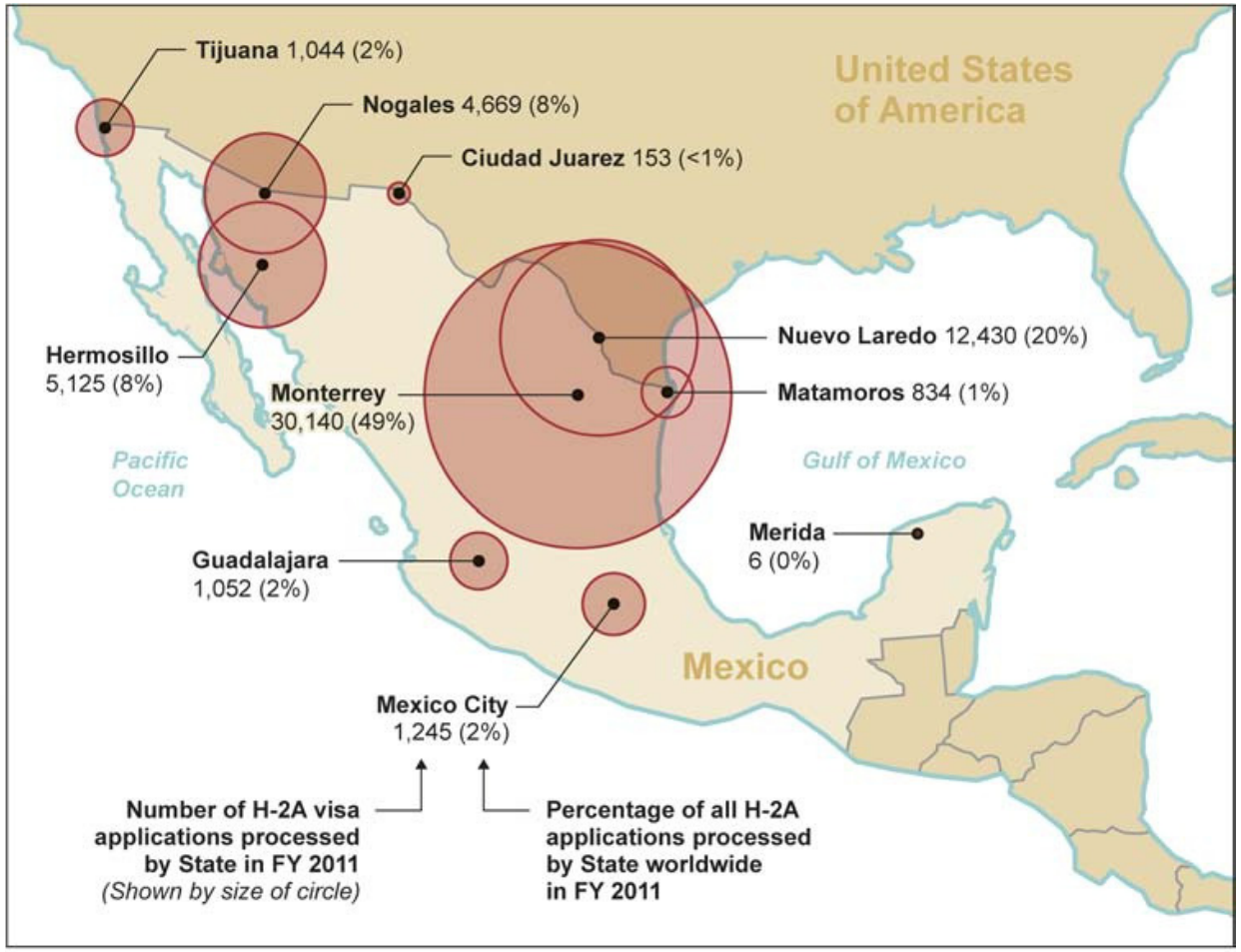
Source: GAO based on USTRANSCOM NGASupport Team NST and Map Resources (map); photograph by James Mollison, August 2004.

Maps show context and scale



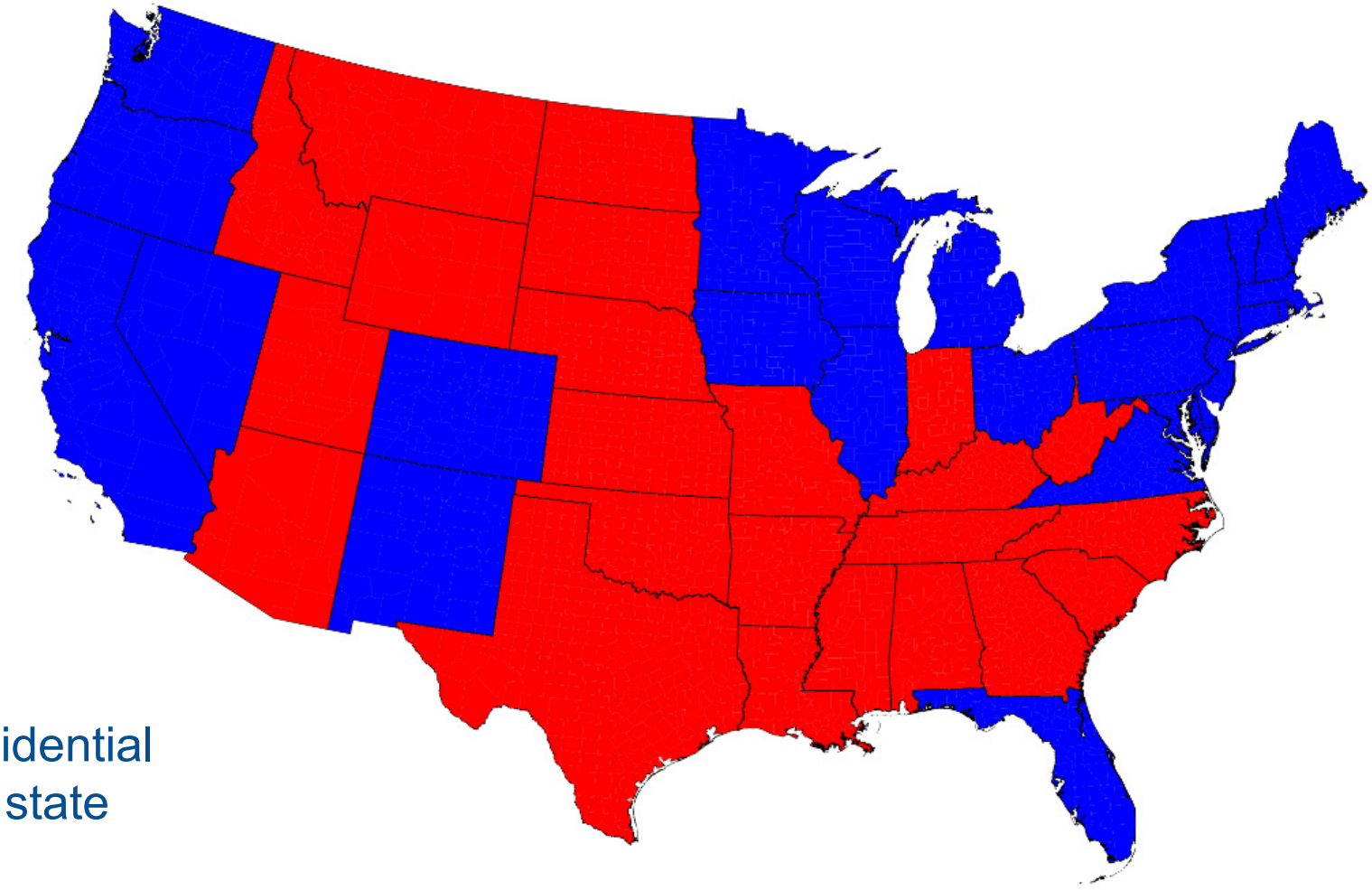
Source: PHMSA.

Maps can be used to "locate" data



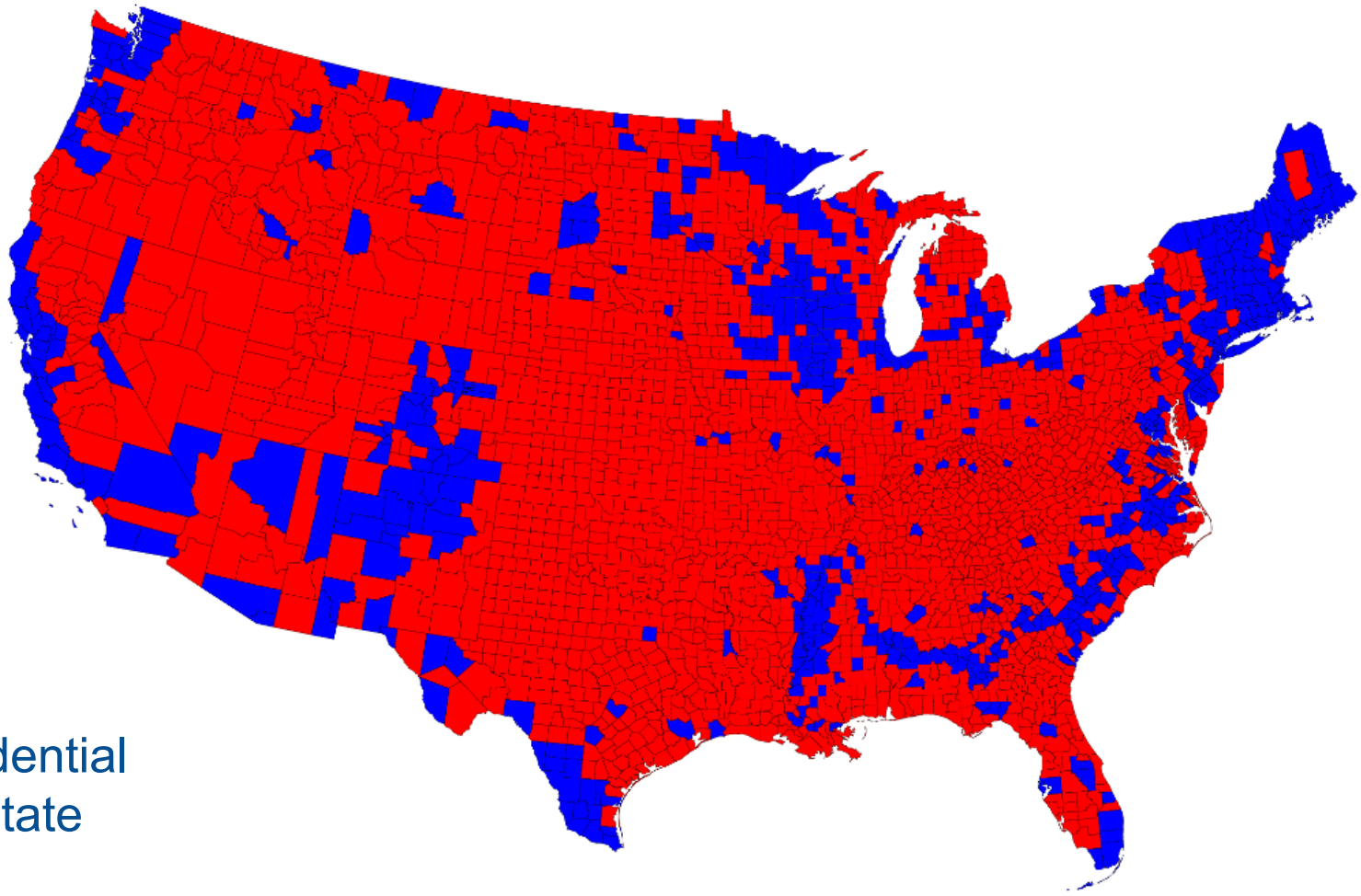
Sources: GAO analysis of State via issuance data; National Atlas of the United States (base map).

Telling a story with heat maps



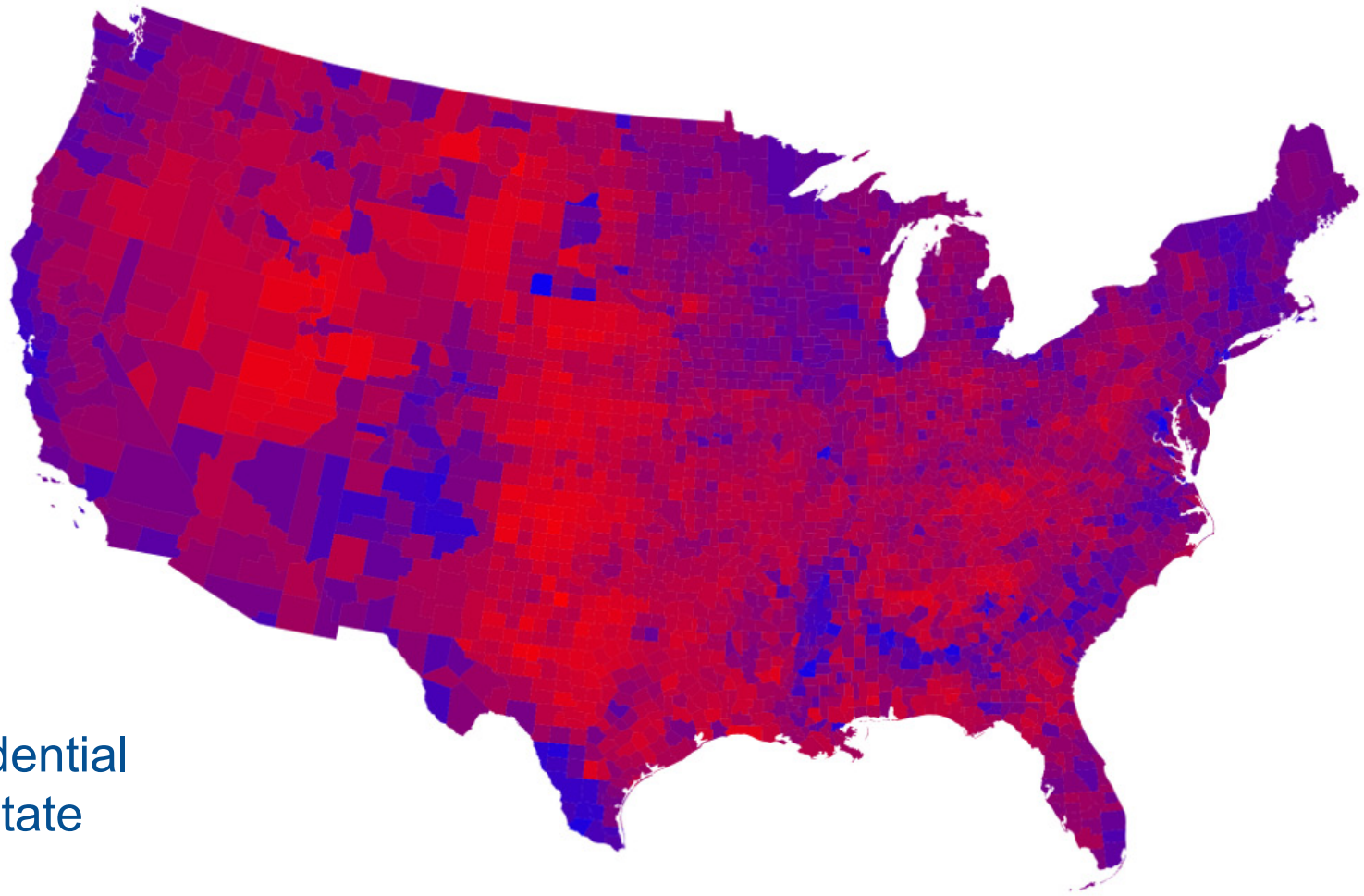
2012 presidential results by state

Telling a story with heat maps



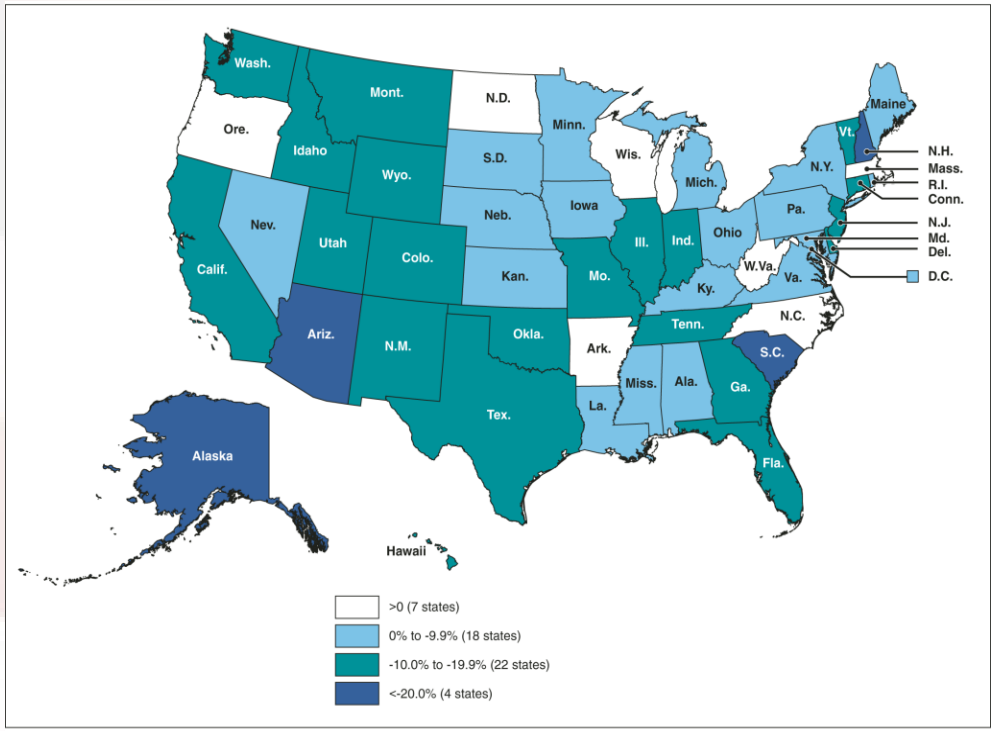
2012 presidential results by state

Telling a story with heat maps

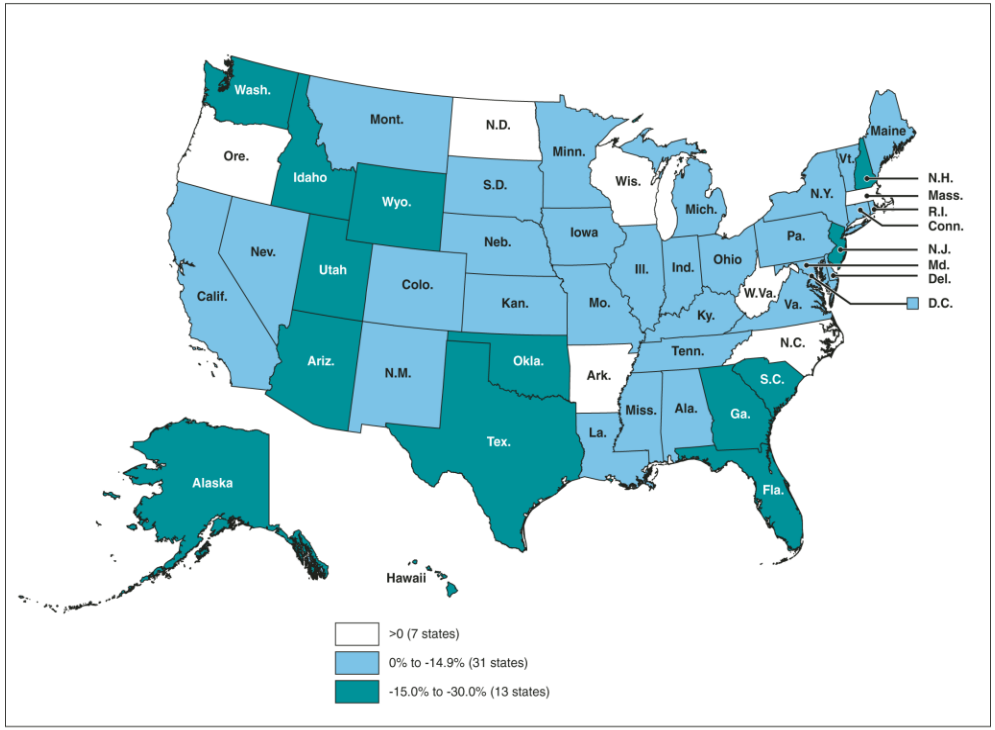


2012 presidential results by state

Heat maps



Sources: GAO analysis of U.S. Census revenue (data); Map Resources (map).

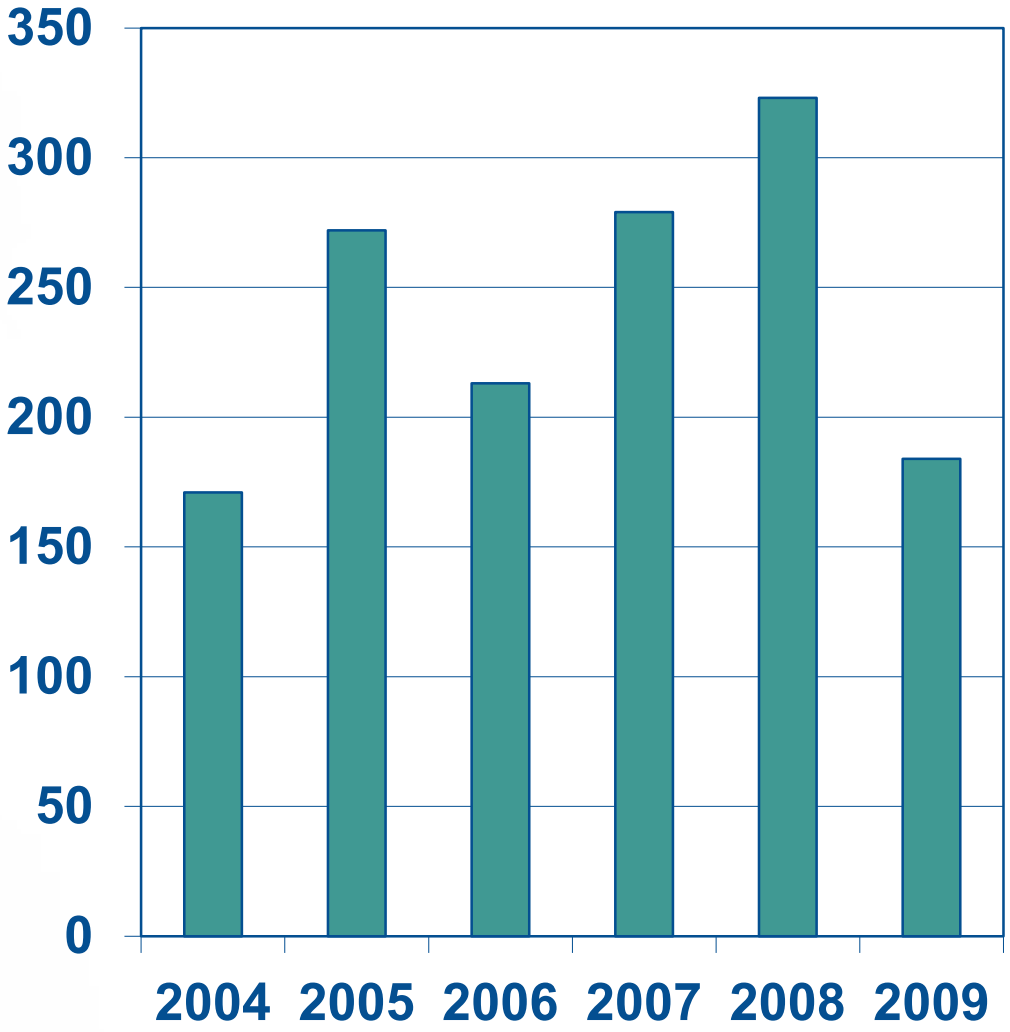


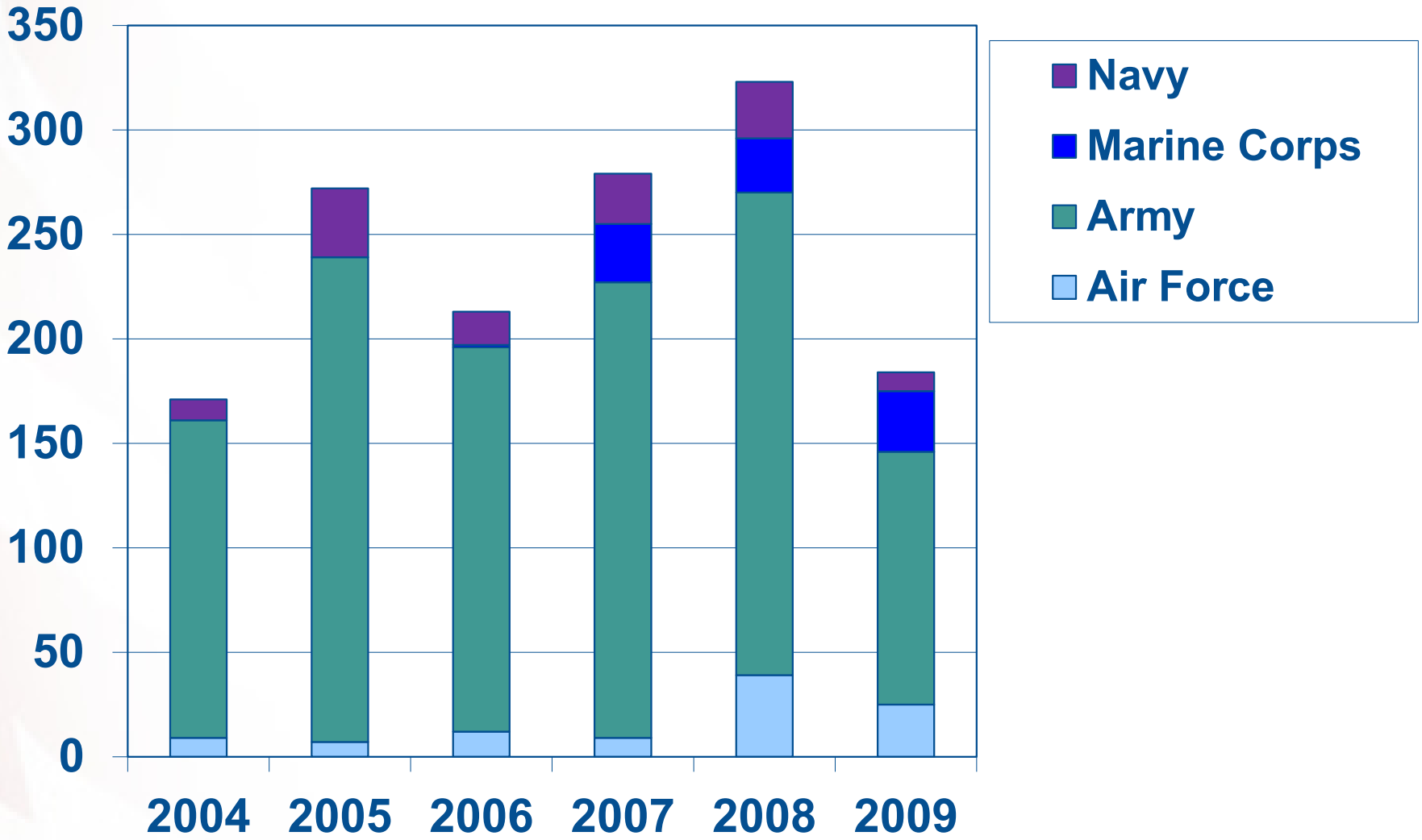
Sources: GAO analysis of U.S. Census revenue (data); Map Resources (map).

Asking the data a question

Table 1: Active Duty Service Members with Critical Occupations Separated under the Homosexual Conduct Policy from Fiscal Years 2004 through 2009

Fiscal year	Air Force	Army	Marine Corps	Navy	Total
2004	9	152	0	10	**171**
2005	7	232	0	33	**272**
2006	12	184	1	16	**213**
2007	9	218	28	24	**279**
2008	39	231	26	27	**323**
2009	25	121	29	9	**184**
Total	**101**	**1,138**	**84**	**119**	**1,442**


350
300
250
200
150
100
50
0
2004
2005
2006
2007
2008
2009


350
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100
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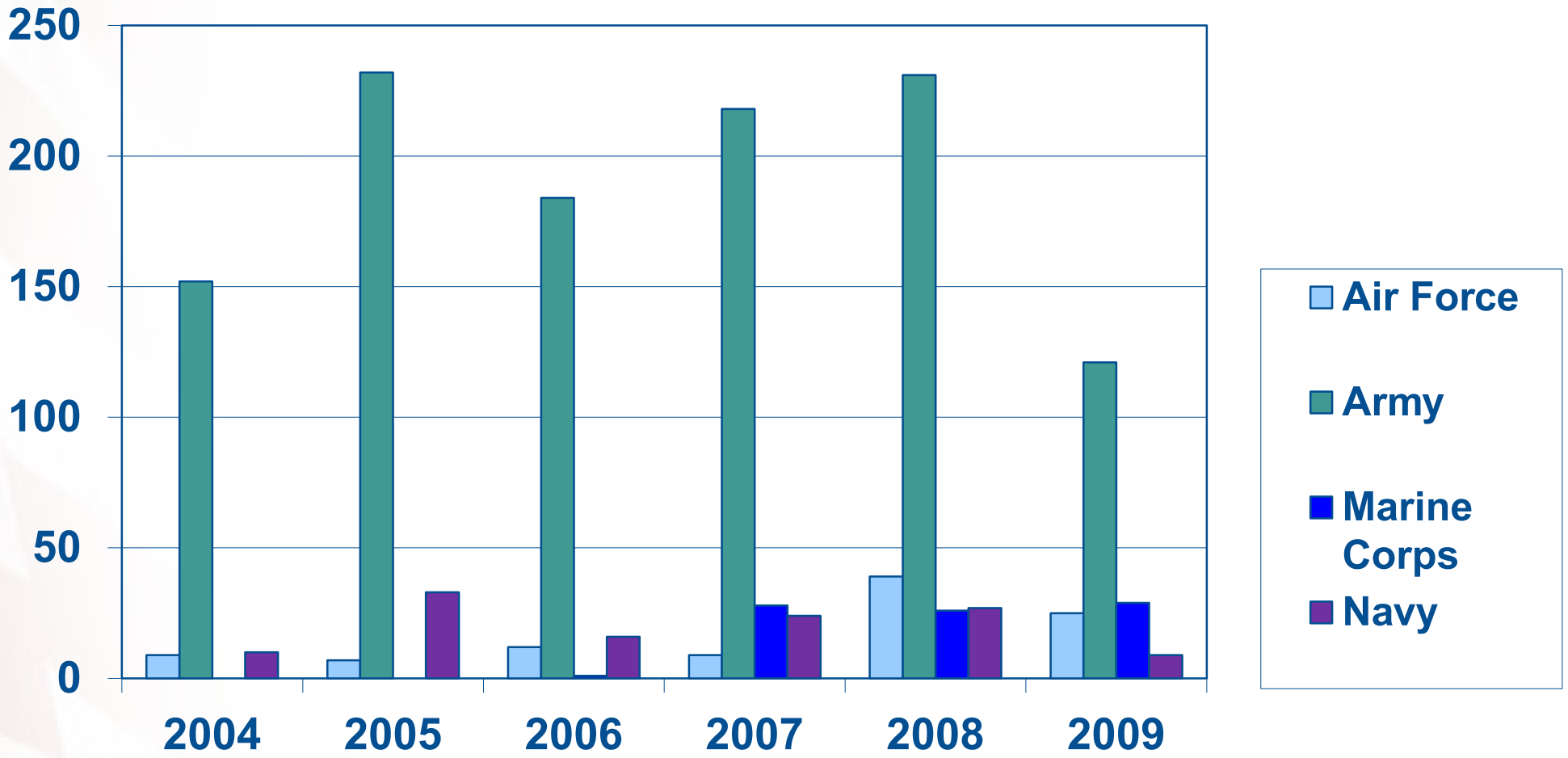
0
2004
2005
2006
2007
2008
2009
Navy
Marine Corps
Army
Air Force


250
200
150
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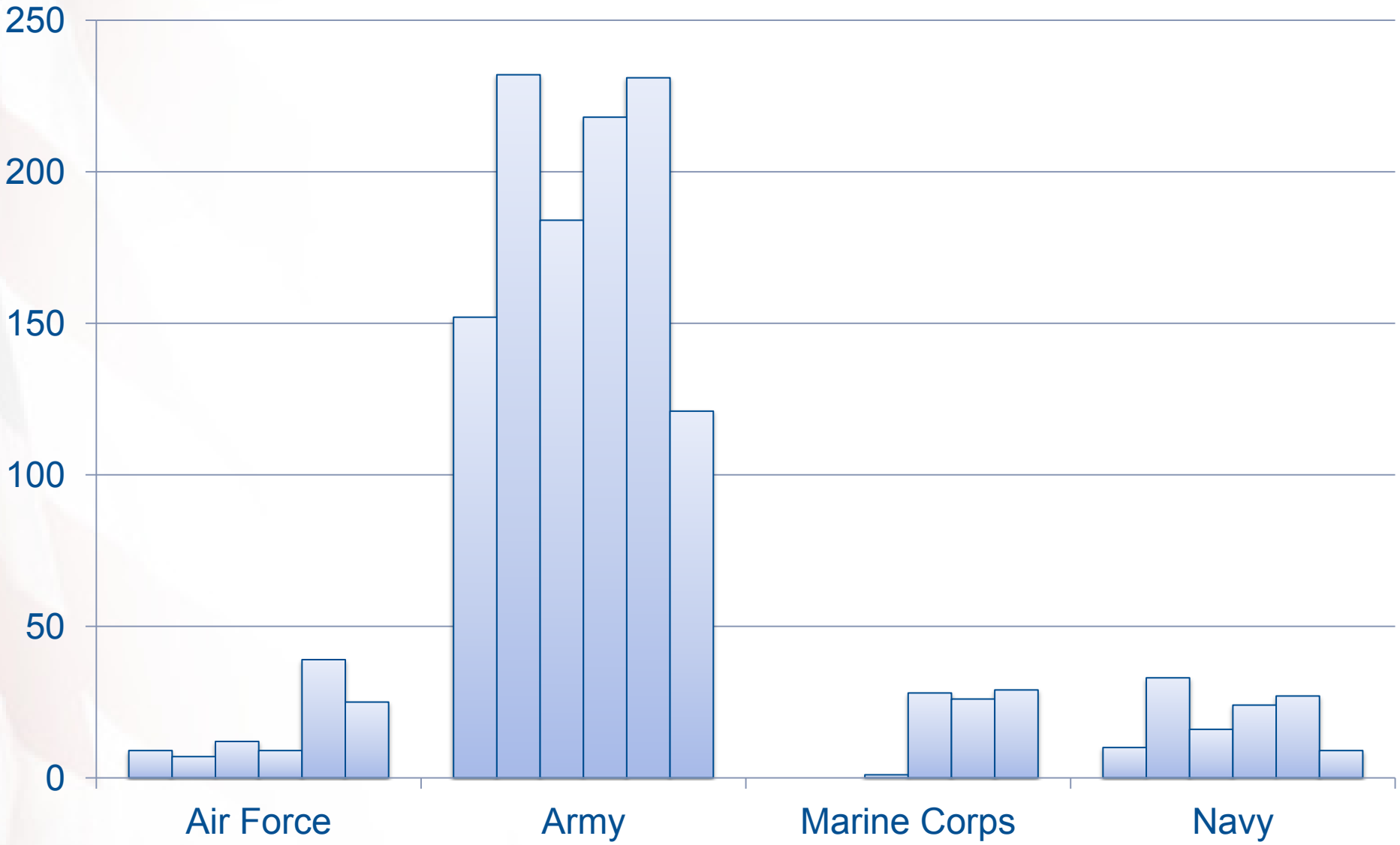
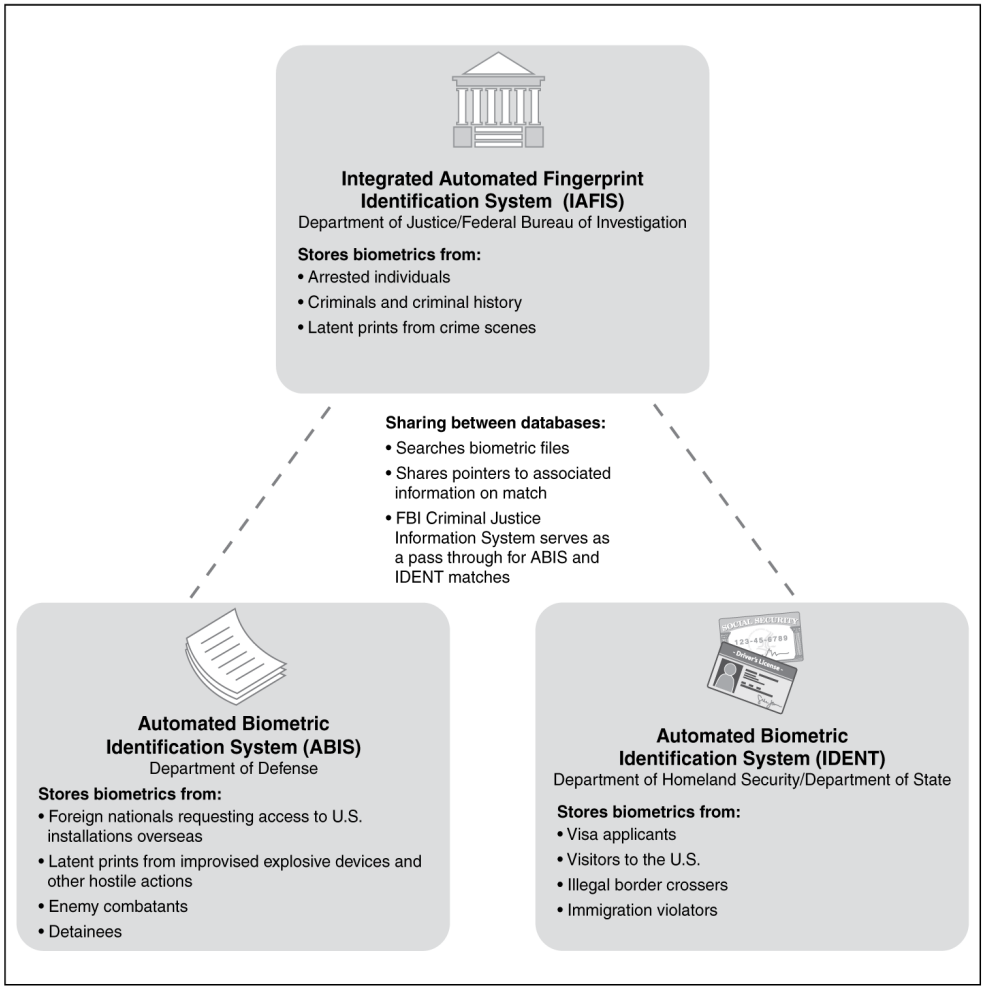
50
0
2004
2005
2006
2007
2008
2009
Air Force
Army
Marine Corps
Navy

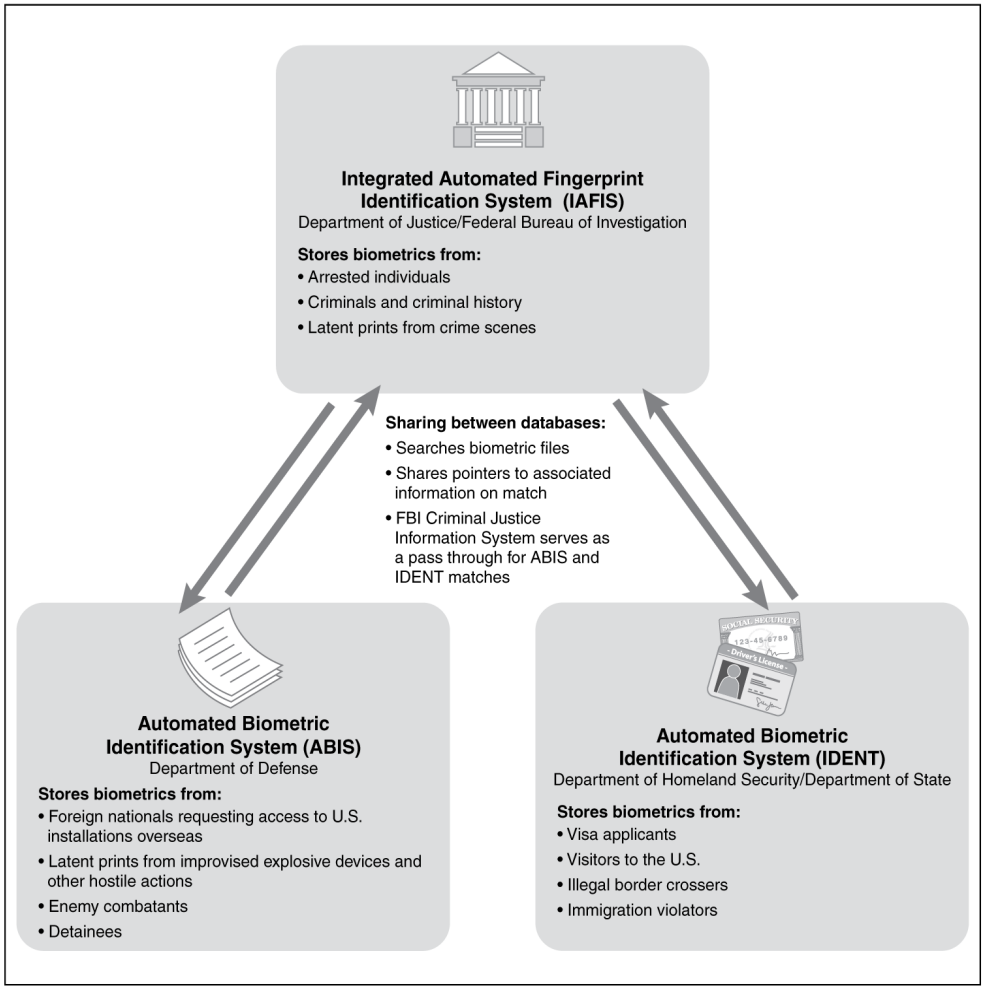

250
200
150
100
50
0
Air Force
Army
Marine Corps
Navy

Developing Graphics



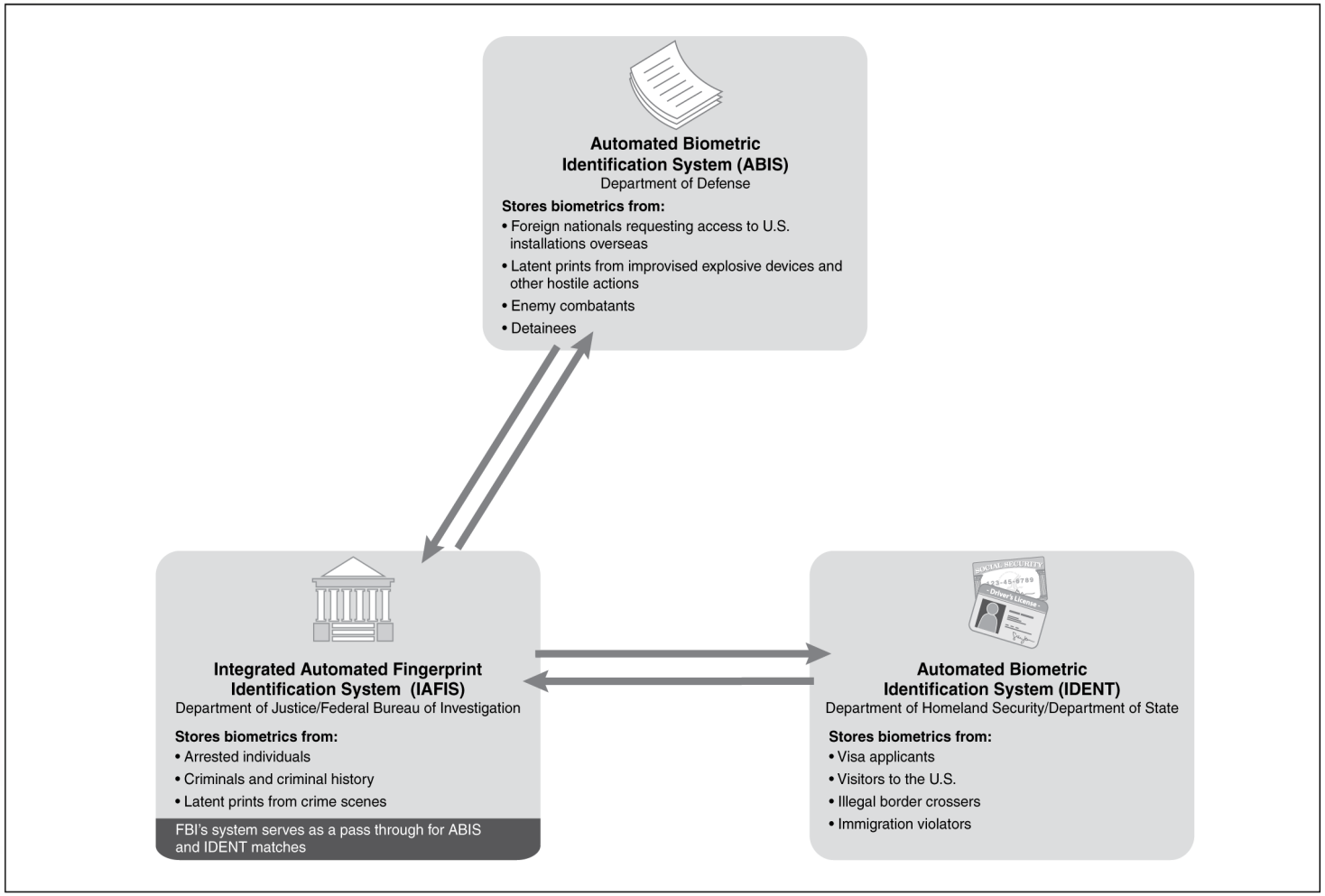
Source: GAO analysis of information provided by DOD, DHS, and the FBI.

Developing Graphics



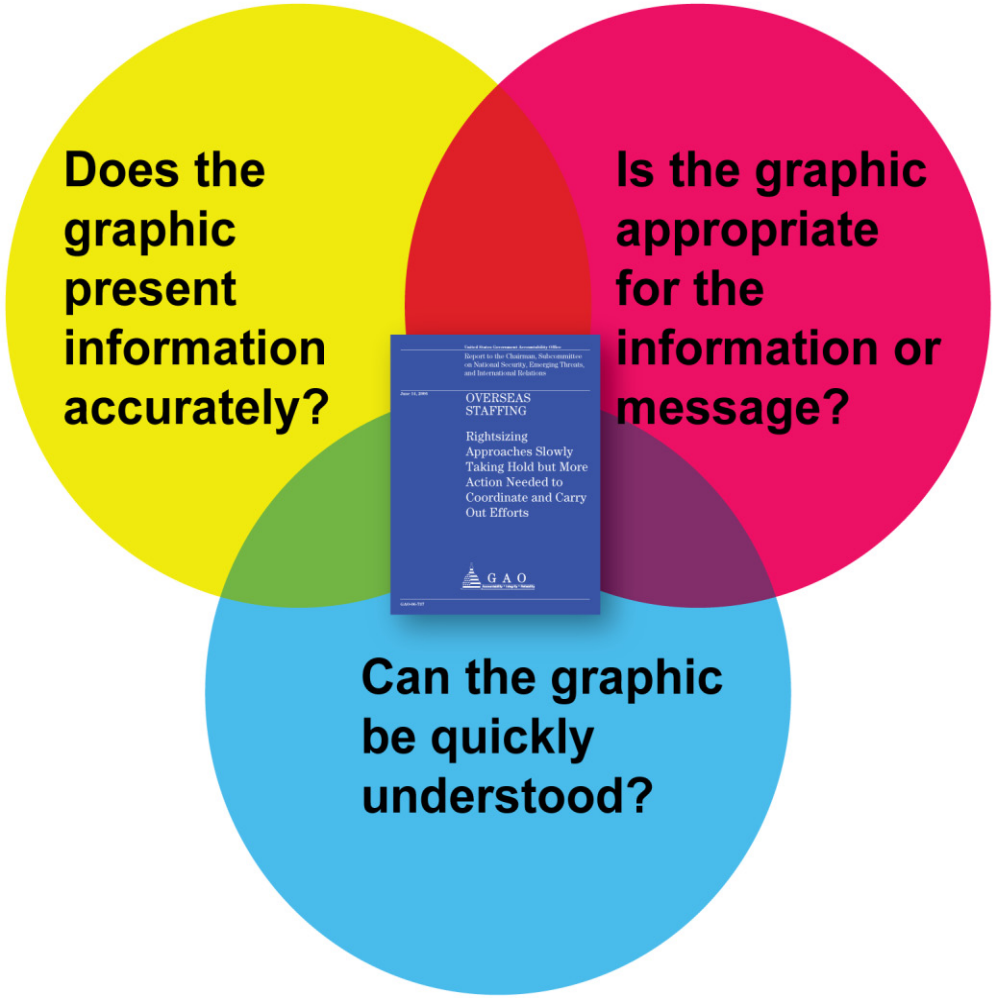
Source: GAO analysis of information provided by DOD, DHS, and the FBI.

Developing Graphics: During Drafting, Version 3



Source: GAO analysis of information provided by DOD.

Key Questions



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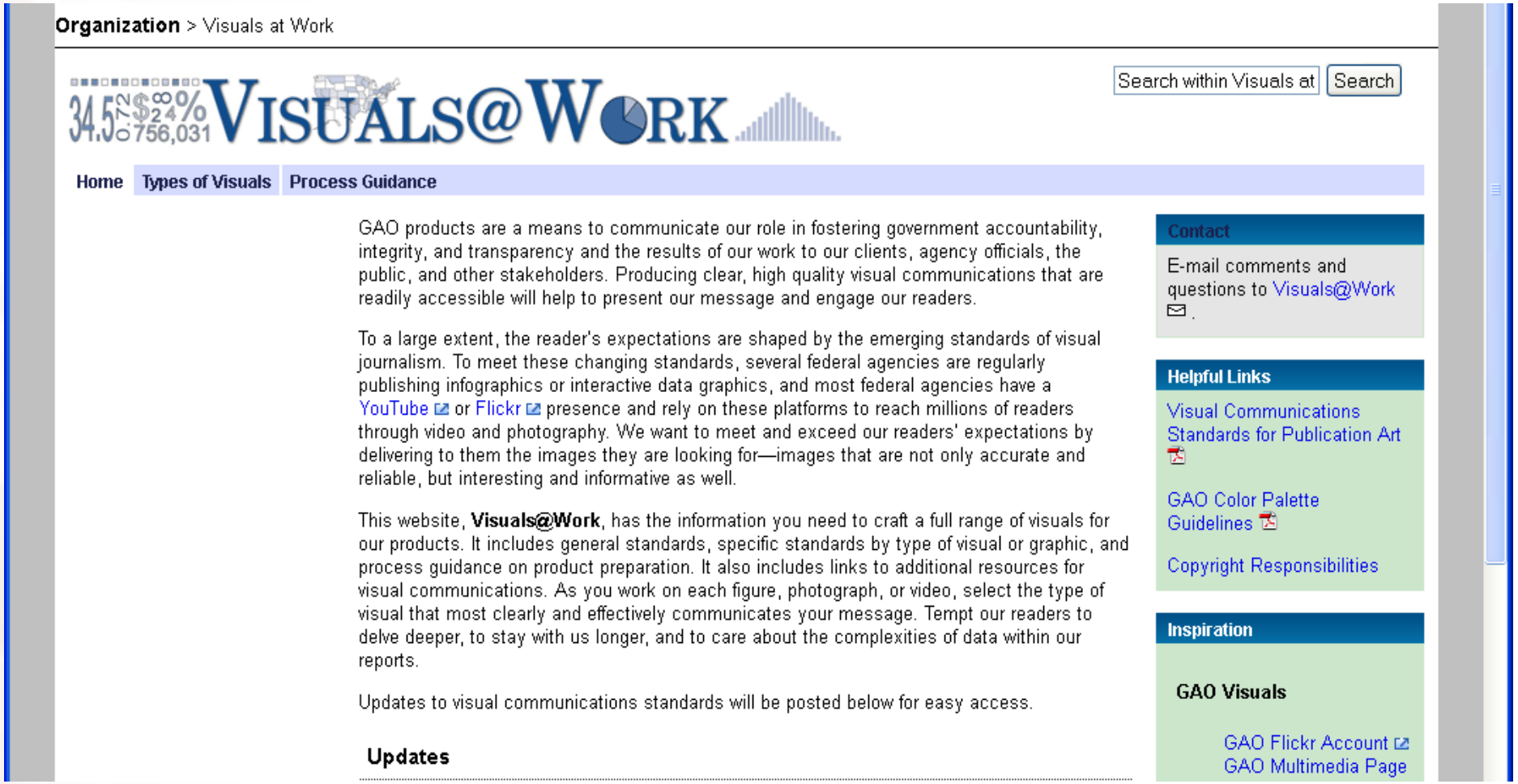
Tips for better graphics

- **Develop a "style"**
- **Fail faster to succeed sooner**
- **Avoid decoration**
- **Work *with* convention**
- **Ask the data for the story**
- **Label things** (directly when possible)
- **Get clear on the units and beware "extreme" data**
- **Be internally consistent**
- **Don't scale finished graphics**

Share your style rules with the group



GAO

Getting the most from your artist

- Tell artist where it's going (slides, report, Web, etc.).
- Involve artist early.
- Refer to job and graphics by name.
- Clarify how your team will handle edits or changes (it often helps to have a single point of contact for graphics).
- Gather up edits and *resend everything* whenever you find "additions"
- Clearly explain what you don't like.