



GeoStats



GPS in Household Travel Surveys: A Range of Options

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Household Travel Surveys (HTS)



- Conducted at regional and statewide level on stratified sample of population to collect basic travel and socio-demographic information
- Resulting dataset is used as input to travel demand model
- Early surveys were conducted using mail-out / mail-back surveys with travel information recorded on travel diaries
- Next generation of HTS were conducted by telephone interviews
- Within past decade, new technologies added to survey toolkit:
 - Web surveys (taken via desktop or laptop PC)
 - GPS logging devices (to passively capture travel details)
 - Smartphone apps (for survey entry or for GPS data logging)
- This presentation will focus on uses of GPS in household travel surveys

Since the Beginning...



- **GPS subsample dual method (diary and GPS)**
 - 2000-2005, diaries for persons, GPS for vehicles (California Statewide, St Louis, and Kansas City – 1 day, Washington DC and Baltimore – 2 or 4 days)
 - Starting with Chicago HTS in 2006, person-based GPS added for multi-modal travel (7 day vehicle and 7 day wearable)
 - 2007 - 2011 person-based GPS (Indianapolis - 1 day and Massachusetts Statewide – 2 or 4 days)
- **Primary purpose – trip rate correction factors**

More Recently...



- **GPS subsample dual method (diary and GPS)**
 - 2010-2012 both options, vehicle and person, used for different purposes / reasons / populations (Denver, Atlanta, California Statewide – 7 day vehicle, 3 or 4 day wearable)
 - 100% GPS and diary sample (Oakland/San Francisco Bay Area – 3100 households, 3 days wearable)
- **Secondary uses of GPS datasets include analyses of mode choice, route choice, congestion and travel times, active transport**

Along the Way...




- GPS-based **prompted recall** subset in diary survey for trip rate correction factors (10% sample NYC metro – 1880 GPS households – 2 or 4 days GPS, followed by CATI or CASI 1 day PR, 2010-2011)
- GPS-based **prompted recall** used for 100% GPS survey (Jerusalem, 8800 households – 1 day CAPI, 2010-2011)
- 100% GPS survey with 30% GPS **prompted recall** subset for imputation algorithm validation/calibration (Cleveland, 4250 households – 3 or 4 days GPS, followed by CATI or CASI 1 day PR, 2012-2013)

NYC Regional Travel Survey (NY-NJ-CT)

Retrieval Mode	Persons			
	GPS		Diary	
	Mean	N	Mean	N
CATI	5.3	2,461	3.9	14,117
CASI	5.6	1,658	4.3	12,042
Mail	0	0	4.3	5,361
Total	5.4	4,119	4.1	31,520

Retrieval Mode	Households			
	GPS		Diary	
	Mean	N	Mean	N
CATI	11.6	1,117	8.2	6,648
CASI	12.1	773	10.6	4,879
Mail	0	0	10.1	2,258
Total	11.8	1,890	9.4	13,785



Report Your Travel

Household: 9900010
 Person: JEAN DOE (p 1)
 Travel on: Friday, December 17 2010

Total Places: **5** Undo [Instructions for Diary reporting](#)

Places with missing information: **0** Redo

[Return to Select Person Page](#)

Place 3 Where Did You Go Next?

A WHAT is this PLACE?

A home, work or school location?
 Home (Home)
 H & E Tool Rental Corporation (Work - JEAN)
 0 (Work - JAMES)

Another location?

A previously visited location?
 Totterville Public library (Amboy Rd & Yetman Ave, Staten Island, NY 103...)
 P K's Under the Bridge Cafe (4908 Arthur Kill Rd, Staten Island, NY 103...)

What is the NAME and ADDRESS of this place? Edit Location

Name of place OR transit stop:

Address OR nearest cross streets:

Type of place:

B What TIME did you ARRIVE at this place? Ex. 2 pm, 1400

C HOW did you TRAVEL to this place?

F Which vehicle did you use?

D How many other travelers with you? number of other people

E Check household members who traveled with you:
 JEAN DOE
 JAMES DOE

H What TIME did you LEAVE? Ex. 2 pm, 1600

[Save Changes](#)

Your Online Travel Diary

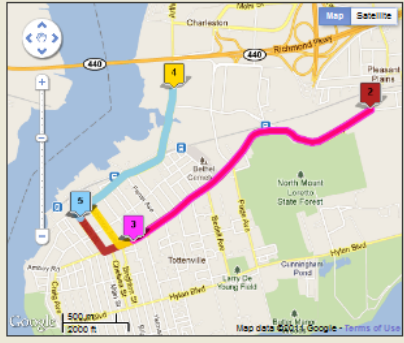
The list of places you visited on your travel day from morning until night:

View	#	Place	Mode	Arrival Time	Departure Time	Duration (hr:min)	
1	1	Home		3:00 AM	7:00 AM	4:00	✓
2	2	H & E Tool Rental Corporation	Auto (car o...	8:30 AM	5:00 PM	8:30	✓
3	3	Totterville Public library	Auto (car o...	5:15 PM	7:30 PM	2:15	✓
4	4	P K's Under the Bridge Cafe	Auto (car o...	7:45 PM	9:05 PM	1:20	✓
5	5	Home	Auto (car o...	9:30 PM	2:59 AM	5:29	✓

[Add New Place](#) [Insert Place Before](#)
[Remove Place](#) [Insert Place After](#)

Google Map of Your Travel

The routes shown between places on the map may not reflect how you traveled. They are here for illustrative purposes only.



[Zoom to All](#) [Zoom to Place](#) [Set Location](#) [Zoom to Trip](#)

ⓘ Don't forget short stops, such as stopping for gas or picking someone up. If you made any stops before your next destination, please report these as separate places.

Reported all of your travel for the day?
 If so, click Done.

[Done](#)

ⓘ To complete your reporting later, click Done and then close this window. Your information is saved and you can log in again to finish reporting your travel.

New York Metropolitan Transportation Council

South Westair Regional Planning Agency

Orange County Transportation Council

Greater Bridgeport Regional Planning Agency

North Jersey Transportation Planning Authority

Valley Council of Governments

Poughkeepsie-Dutchess County Transportation Council

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Jerusalem 100% GPS Travel Habits Survey

GeoStats Trip Builder - 1.0.3699.19218

סך מקומות: 41
לא מאושר: 41

יום הנסיעות: 12/02/2010
סוג הירוס: דסה-לוגר

משק בית: 1000001
מכיל הכות, פרט 1 ממוז 2

לאן הלכת לאחר תכן? [מקום 3] חחח

מסך הניקור: מקום נפוצ: מקום קודם: מסעדה מקום אחר:

זמן הגעה למקום: 0713
זמן עזיבה מהמקום: 0733

אמצעי: איד הגעת למקום הזה?
ארטובוס
אחר:
או פצל למספר אמצעים...

חירוש: תוצאות החירוש:

שם: %
כתובת:
מספר:
קומה/דירה:
עיר:
צומת או מקום:

מס' מקום	על המפה	מקום	אמצעי	זמן הגעה	זמן עזיבה	זמן שהייה	מטרה	מאושר
1	<input checked="" type="checkbox"/>					03:00	06:24	3.24
2	<input checked="" type="checkbox"/>		ארטובוס	06:44	07:12	07:12	0:27	
3	<input checked="" type="checkbox"/>		ארטובוס	07:13	07:33	07:33	0:19	
4	<input checked="" type="checkbox"/>		ארטובוס	07:37	07:42	07:42	0:05	
5	<input checked="" type="checkbox"/>		נהג מכוונ...	07:56	08:02	08:02	0:05	
6	<input checked="" type="checkbox"/>			08:41	08:42	08:42	0:00	
7	<input checked="" type="checkbox"/>	צמ"א	הליכה	08:50	14:17	14:17	5:26	
8	<input checked="" type="checkbox"/>	מסעדה	הליכה	14:18	15:35	15:35	1:17	
9	<input checked="" type="checkbox"/>		נהג מכוונ...	16:27	16:33	16:33	0:05	
10	<input checked="" type="checkbox"/>		נהג מכוונ...	16:44	16:53	16:53	0:09	
11	<input checked="" type="checkbox"/>		נהג מכוונ...	17:04	18:29	18:29	1:24	
12	<input checked="" type="checkbox"/>		נהג מכוונ...	18:38	07:33	07:33	12:55	
13	<input checked="" type="checkbox"/>		ארטובוס	07:35	07:44	07:44	0:08	
14	<input checked="" type="checkbox"/>		נהג מכוונ...	08:01	08:07	08:07	0:05	


הוסף מקום חדש | השתמש בנטיעה | הוסף לפני | הוסף אחר

הסר מקום | הסר מסלול שוגא

מסלול: m 647134.4, 201196.7

עיר: מודיעין מכבים רעות | שכונה:

Jerusalem Trip and Tour Rate Results



Sector	Person Type	No. of Participants					Trip Rate			Tour Rate		
		Cars	GPS	Non-GPS	Non-Mobile	Non-Mobile	% GPS exclude	GPS	Non-GPS	Ratio	GPS	Non-GPS
1=Secular	1=Worker	0	295	42	44	87.5%	4.02	3.14	1.28	1.34	1.12	1.19
		1+	1,629	145	110	91.8%	5.38	3.56	1.51	1.62	1.21	1.33
	2=Non-worker	0	238	39	140	85.9%	4.16	2.95	1.41	1.44	1.18	1.22
		1+	472	49	137	90.6%	4.92	3.00	1.64	1.70	1.24	1.37
	3=School	0	37	3	12	92.5%	3.84	3.33	1.15	1.30	1.67	0.78
		1+	190	18	42	91.3%	3.58	2.72	1.31	1.31	1.22	1.07
2=Orthodox	1=Worker	0	247	67	24	78.7%	4.32	3.46	1.25	1.53	1.39	1.11
		1+	165	23	10	87.8%	6.47	3.17	2.04	1.95	1.26	1.54
	2=Non-worker	0	443	148	130	75.0%	5.33	3.87	1.38	1.88	1.74	1.08
		1+	125	23	26	84.5%	5.94	4.74	1.25	2.01	2.09	0.96
	3=School	0	94	54	12	63.5%	3.62	2.26	1.60	1.33	1.07	1.24
		1+	48	15	8	76.2%	4.04	2.20	1.84	1.56	0.93	1.67
3=Arab	1=Worker	0	116	19	32	85.9%	3.70	2.11	1.76	1.19	0.95	1.26
		1+	366	33	50	91.7%	4.97	2.42	2.05	1.34	1.06	1.26
	2=Non-worker	0	130	9	167	93.5%	3.11	2.44	1.27	1.08	1.00	1.08
		1+	203	19	242	91.4%	3.88	2.79	1.39	1.31	1.11	1.18
	3=School	0	73	8	32	90.1%	2.74	2.00	1.37	1.08	1.00	1.08
		1+	124	14	52	89.9%	2.75	2.14	1.28	1.10	1.00	1.10

Cleveland GPS Household Travel Survey: Pretest and Pilot Study Design



Pretest (September 2011)

- 5 task force or staff participant households in PR subsample to test materials, methods, questionnaires

Pilot (October – November 2011)

- 150 hh recruited (original goals: 50 PR, 100 GPS only)
- All persons of age 13 – 75 provided with wearable GPS data logger for three days (four days if first day is Friday)
- 75+ only hh created new category: Log only
- Incentives offered, tailored to level of burden

Cleveland Pilot Study Results



Phase	% CATI	% WEB	Total Recruits	Total Retrieved / Completed	% CM
Recruitment (all)	57%	43%	150	102	68%
Retrieval (PR Only)	53%	47%	41	30	73%
Retrieval (GPS Only)	NA	NA	94	67	71%
Retrieval (Log Only)	NA	NA	15	5	33%

- High use of web recruitment and of web retrieval (PR households)
- The retrieval rate for GPS only and GPS+PR households exceeded expected rates by a few percentage points
- Log only households did not mail back completed logs as expected

Cleveland Main Survey Overview



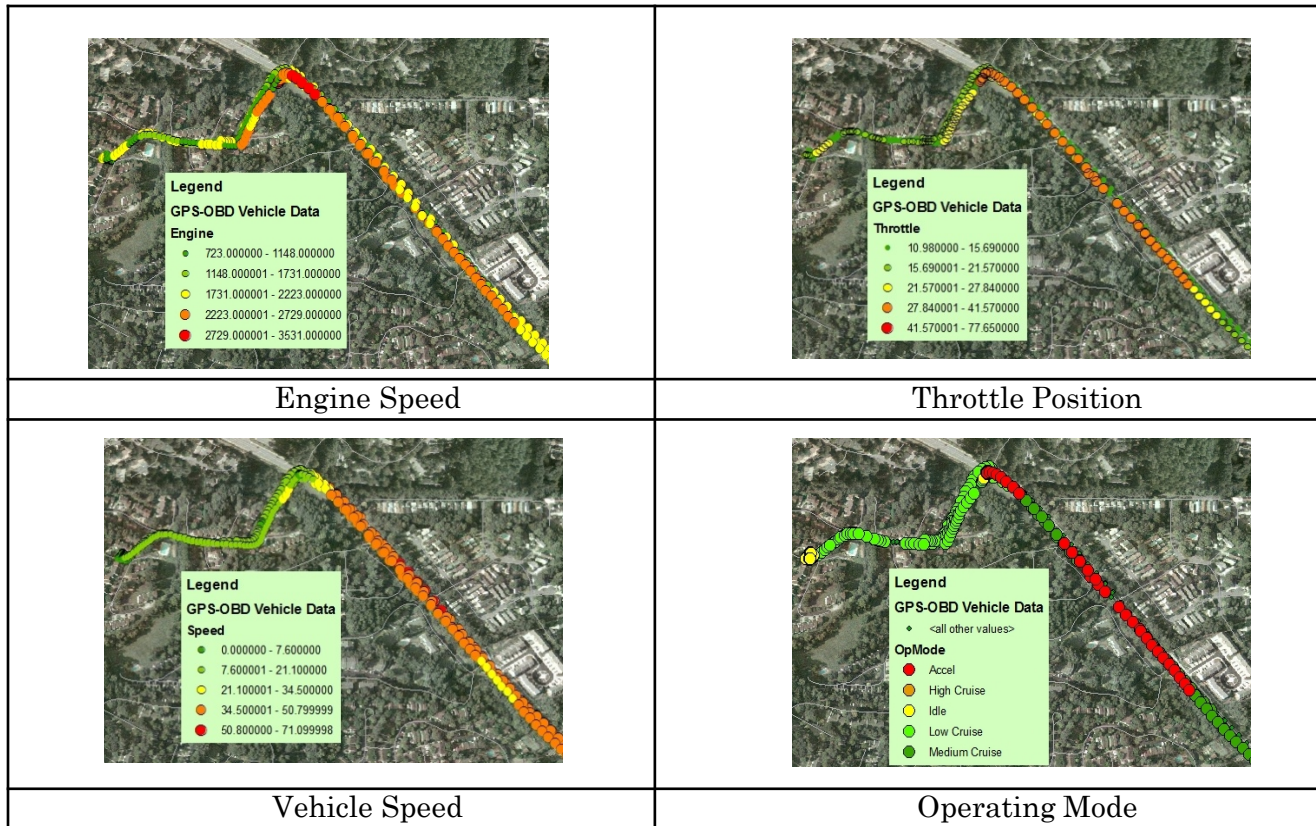
- **4,250 Complete Households**
 - 2,575 Households GPS-only (no travel retrieval)
 - 1,250 Households GPS-based Prompted Recall (PR)
 - 425 Households Log only (75+ households)
- **12-month data collection period starting on Feb 15, 2012**
- **Travel details for GPS-only sample to be derived /imputed**

Extensions for Vehicle Activity



- **Vehicle GPS and Onboard Diagnostic (OBD) sensors (California Statewide Travel Survey – 1300 households, 2012-2013)**
 - GPS device measures all vehicle trips (second-by-second traces with instantaneous speed and heading)
 - OBD device measures engine activity (mass air flow, engine speed, engine load, throttle position – 5 second frequencies)
 - Combined metrics can be used for fuel consumption and emissions modeling
 - 500 households from alternative fuel vehicle sample

Sample GPS and OBD Data



Engine Speed

Throttle Position

Vehicle Speed

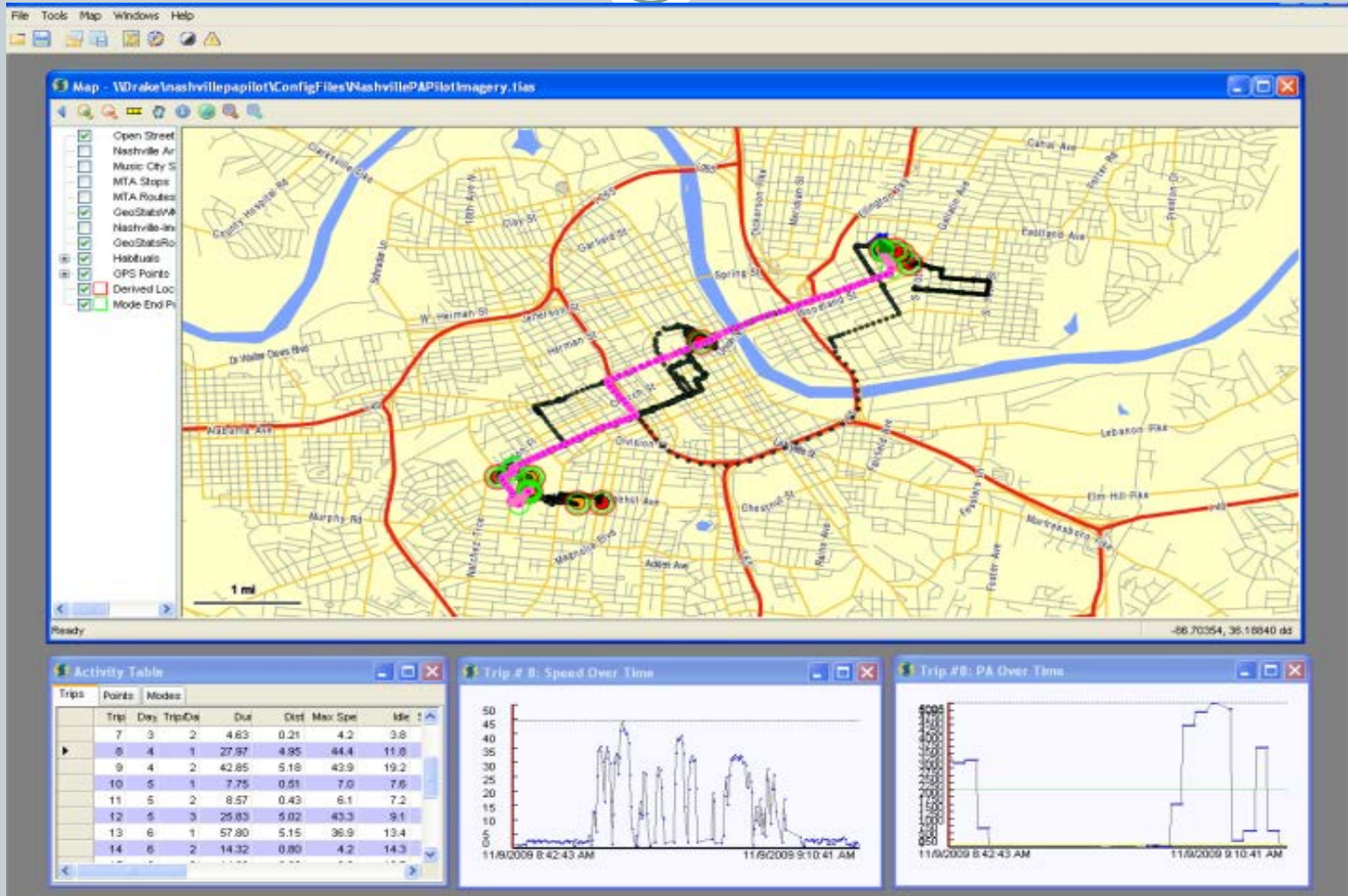
Operating Mode

Extensions for Physical Activity



- **Wearable GPS and / or accelerometers (activity monitors) for measuring travel and physical activity (Atlanta – 500 households 2001-2002, Nashville – 600 households, 2012)**
 - GPS devices measure all modes of travel (second-by-second)
 - Accelerometers measure physical activity intensity
 - Both devices in tandem identify where / how physical activity occurs

Nashville Walk-Bus-Walk Trip



Trends over the Past Decade

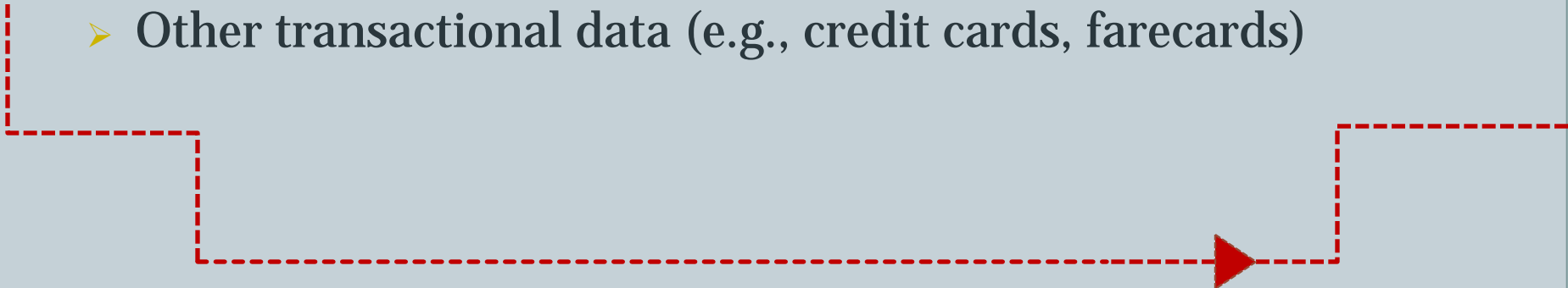


- **Increasing size of GPS subsamples**
 - Primary purpose: trip rate correction factors for diary participants
- **Longer deployment durations and longer study durations**
- **Expansion from dual method to GPS only method**
 - There is still value in dual methods for some agencies
- **Although wearable devices are commonplace, doesn't necessarily mean that they are only solution**
 - Vehicle approach appropriate for certain goals and has lower burden
- **Agencies see value of GPS data beyond correction factors**
- **GPS loggers used in tandem with other sensors to meet additional data needs**

The Future



- **Multi-modal surveys (web, phone, mail, GPS)**
 - “Different strokes for different folks”
- **GPS only surveys (with or without prompted recall)**
 - Standalone GPS data loggers
 - Smartphone data logging apps
- **Data mining of large-scale consumer datasets**
 - GPS data from personal navigation devices, smartphones
 - Other transactional data (e.g., credit cards, farecards)



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- The travel surveys, of which these GPS components were a part, were led by numerous firms, including PTV NuStats, Parson Brinckerhoff, GeoStats, and Westat.
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Thanks!

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