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Charting Undergraduate Research: A Review of the URA Program

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Charting Undergraduate Research:

A Review of the URA Program

Ricky Mouser

Mentored by Dr. Bob Kehoe and Susan Kress

Southern Methodist University

Engaged Learning

Written May 3, 2013

Submitted as Final Project April 11, 2014

Project Background

At the end of my sophomore year, Engaged Learning coordinator Susan Kress approached me for help. SMU had finally compiled preliminary data on who was joining our undergraduate programs and what their research outcomes were, but she needed assistance analyzing it all. In the past, this information had been so decentralized and poorly managed that it was almost completely opaque to administrative eyes. Funding for these programs spiraled unchecked as more and more students were being accepted on individual basis, without any comprehensive overview of program admissions. But with all of this missing data finally coming together in enormous spreadsheets, it was equally daunting to university administrators to try to wade through the mass of new information. After watching my term presentation for a graduate-level statistics course, Susan was optimistic that I would bring the diligence, technical skills, and communicative ability to right the ship.

I went through several revisions with administration to establish and fine-tune the most important metrics and charts for program organizers to have on hand. However, it soon became clear to me that my personal intervention was only a short-term solution. Hiring a new statistics student every year or two to oversee the same operation would require wasteful investments in training time and salary, and harm the smooth continuity of the analysis. To give the university a lasting method of monitoring these relevant trends and breakdowns, I needed to streamline and ultimately automate data analysis and visualization so that even non-technical staff could continue this work after my graduation. Any system perceived as too technical to use *easily* would simply go unused, so my solution needed to be straightforward and intuitive.

Knowing this, I produced two easy-to-use Excel sheets to automatically read in each program's yearly rosters. These sheets instantly convert raw data files into presentation-quality output that is summarized, analyzed, and displayed both longitudinally and as individual years. Every chart populates itself from the raw data files, and *every question* that SMU administrators have ever asked me can be neatly answered within seconds of reading in new program rosters. Are freshmen's GPAs more negatively affected than seniors' by taking on the out-of-classroom demands of research? Are there systematic imbalances in student participation by gender or race? After spending my junior year testing and tweaking everything, my system promised to end the guesswork or blind hopefulness surrounding these matters, but it remained to be seen whether SMU faculty and staff would embrace it.

This year, I have been pleasantly surprised to notice the charts and figures produced by my Excel sheets popping up in more and more SMU publications. Whole research programs I never personally analyzed are finally receiving the attention and guidance that they need now that they can run their data through my spreadsheets. I am very proud that my system has proved simple and useful enough for non-statisticians to accept. As a statistics major, many projects I work on are far more technically demanding or statistically complex, but the impact of my work at Engaged Learning has a different kind of staying power. I truly benefited from my experiences as an undergraduate researcher, so knowing that my work will help these same programs survive and thrive is very personally rewarding.

About this Document

The automated spreadsheets were first created and calibrated using data from the URA program through the Fall/Spring 2012-13 term. The document below represents an ongoing dialogue with my mentors, Dr. Bob Kehoe and Susan Kress. To determine exactly what information the SMU administration would need to have on hand, I copied output directly from my spreadsheets into this document and provided some light analysis to help contextualize the results. Through several iterations of this process, Dr. Kehoe and Susan Kress were incredibly helpful in asking the right types of questions to create even more useful output. Note that any and all highlighted text responds directly to the

questions asked by my mentors during this time. Within these pages lie experimentation and the outline for face-to-face roundtable discussions; I hope that later readers will forgive the relative informality, lack of complete contextualization, and density of output in the document itself.

Overview of Results

In general, we were pleased to find that most initial problems with demographic inequality by factors such as race or student classification (year) have steadily trended towards more egalitarian outcomes as the program has grown over time. No evidence was found of GPAs being harmed by participation, even for younger students or those working many hours, and most students actually experience mild GPA improvements during their research. On the other hand, there remains work to be done to ensure that the diversity of schools and divisions represented by these student researchers continues to grow and expand.

Technical Note

The use of "total" data does not include the Fall/Spring 2012-13 term unless otherwise specified.

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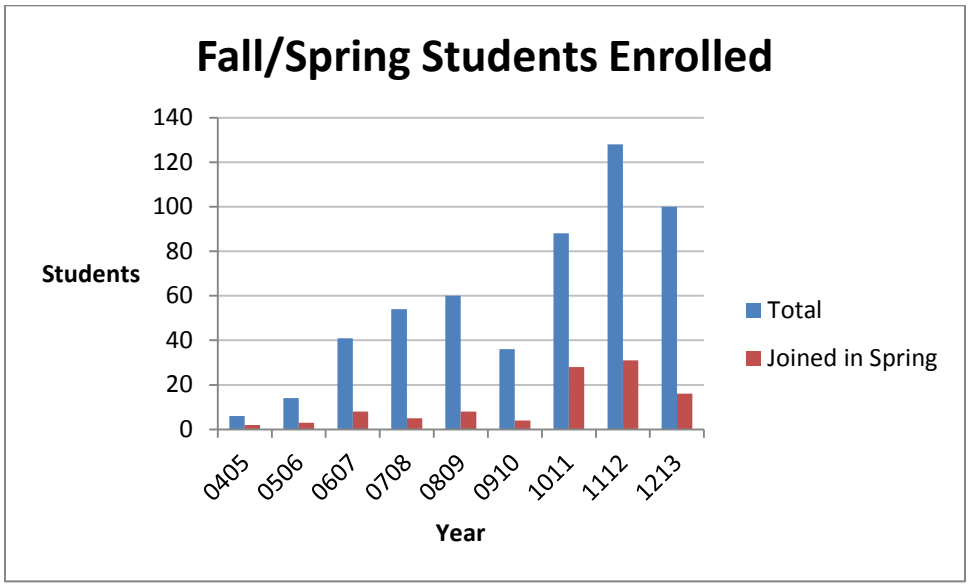
Growth of Program

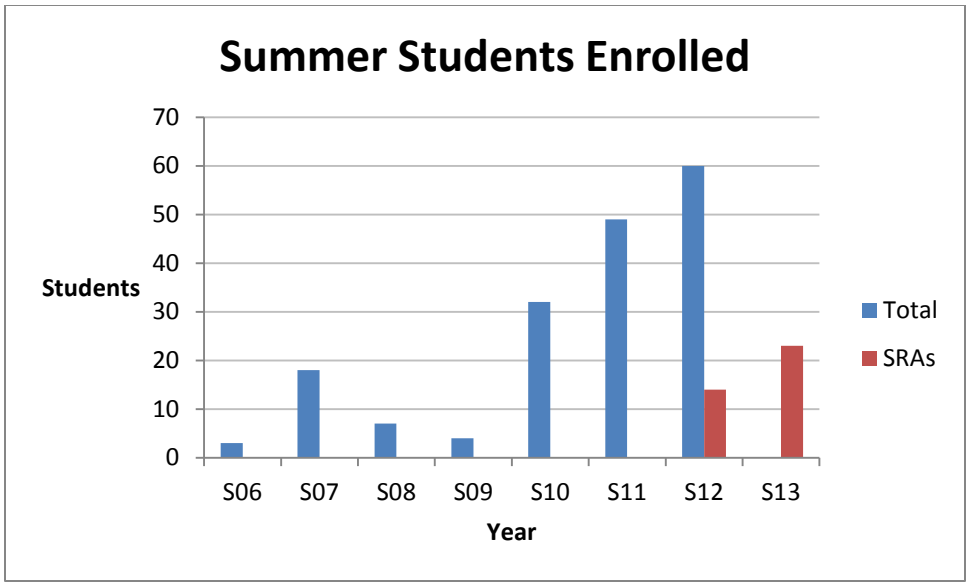
The program has experienced significant growth over the past several years.

Enrollment for the Fall/Spring 2012-13 term is only slightly less than that of 2011-12. Much of the growth over the past few years is attributable to a recent increase in Spring enrollment.



Year	Total	Spring
0405	6	2
0506	14	3
0607	41	8
0708	54	5
0809	60	8
0910	36	4
1011	88	28
1112	128	31
1213	100	16
Total	527	105

The new SRA program is a subset of the Summer URA Program for students working many hours.



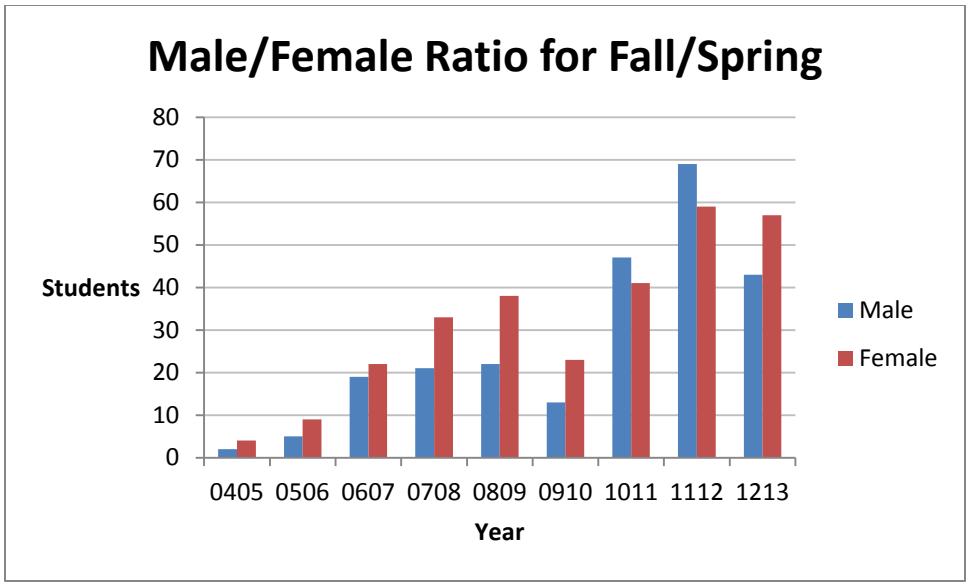
Year	Total	SRA
S06	3	0
S07	18	0
S08	7	0
S09	4	0
S10	32	0
S11	49	0
S12	60	14
S13	0	23
Total	173	37

Student Demographics

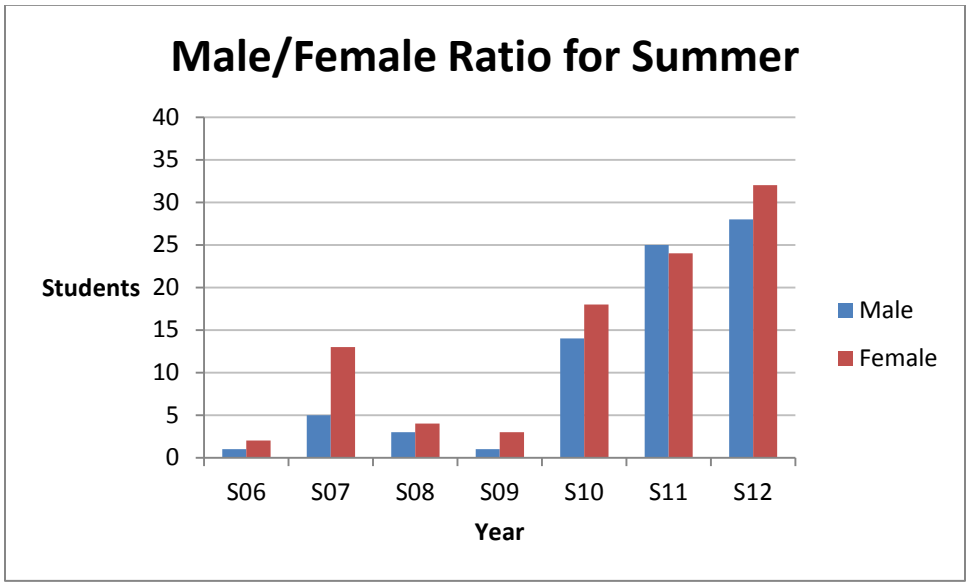
Gender Demographics

Historically, 46% of Fall/Spring students and 45% of Summer students are male. In particular, having just 46% of 527 Fall/Spring students be male is statistically significant.

It is our belief that this disparity comes almost entirely from the 2007-08 and 2008-09 terms, but has since stabilized; over the last four years, 49% of Fall/Spring students and 47% of Summer students have been male.



Year	Male	Female
0405	2	4
0506	5	9
0607	19	22
0708	21	33
0809	22	38
0910	13	23
1011	47	41
1112	69	59
1213	43	57
Total	241	286



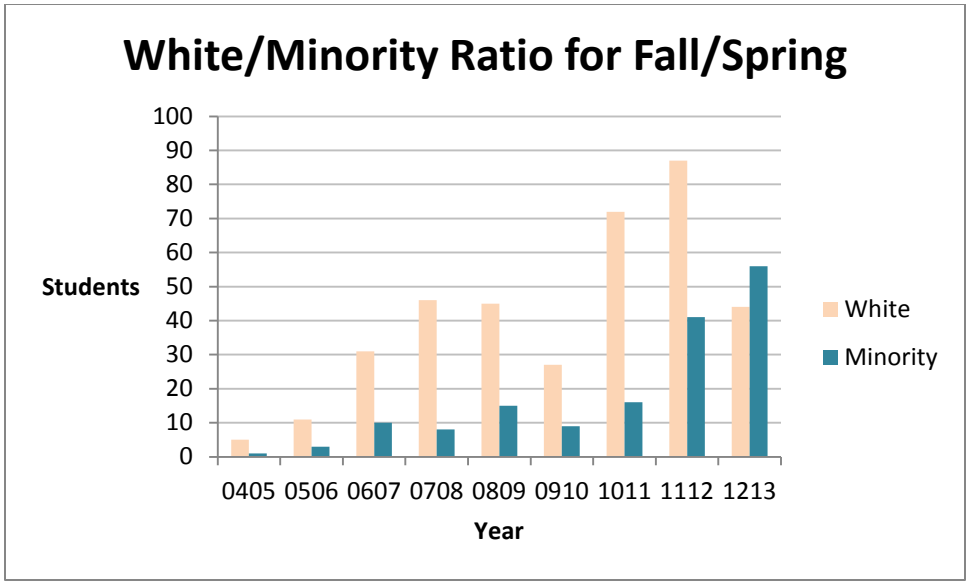
Year	Male	Female
S06	1	2
S07	5	13
S08	3	4
S09	1	3
S10	14	18
S11	25	24
S12	28	32
Total	77	96

We investigated whether there was some linear trend between proportion of students who were female and time. We did not find a significant linear trend for either Fall/Spring or Summer (p=0.09, p=0.15), and simple visual inspection shows that it was two years in the middle of the data – 2007-08 and 2008-09 – that account for virtually all of the disparity. (Summer term findings are extremely similar)

Race Demographics

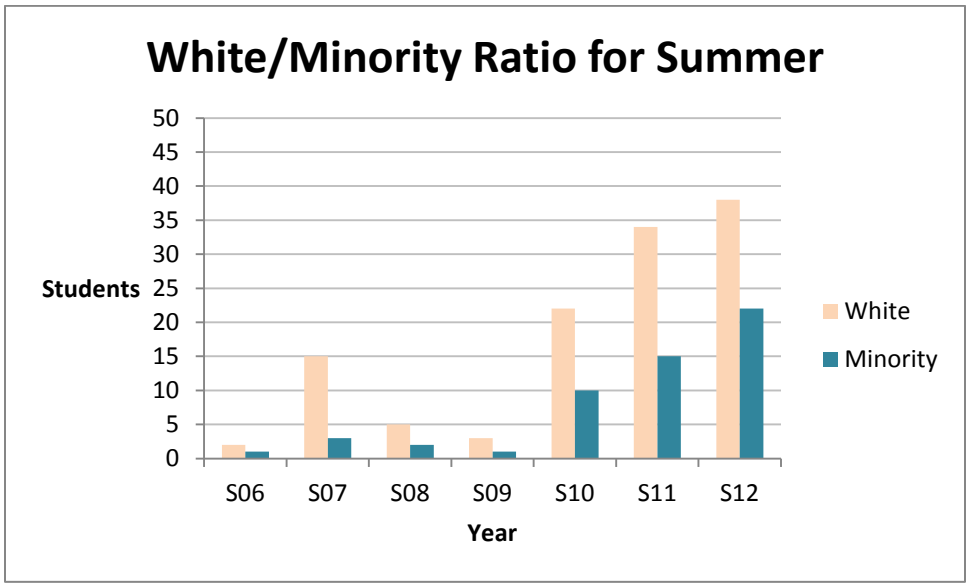
Historically, 70% of Fall/Spring students and 69% of Summer students are white.

The racial makeup of the URA program used to be even more strongly dominated by whites in the past, but in recent years we have seen a shift towards greater diversity, as shown below.



Year	White	Minority
0405	5	1
0506	11	3
0607	31	10
0708	46	8

0809	45	15
0910	27	9
1011	72	16
1112	87	41
1213	44	56
Total	368	159



Year	White	Minority
S06	2	1
S07	15	3
S08	5	2
S09	3	1
S10	22	10
S11	34	15
S12	38	22
Total	119	54

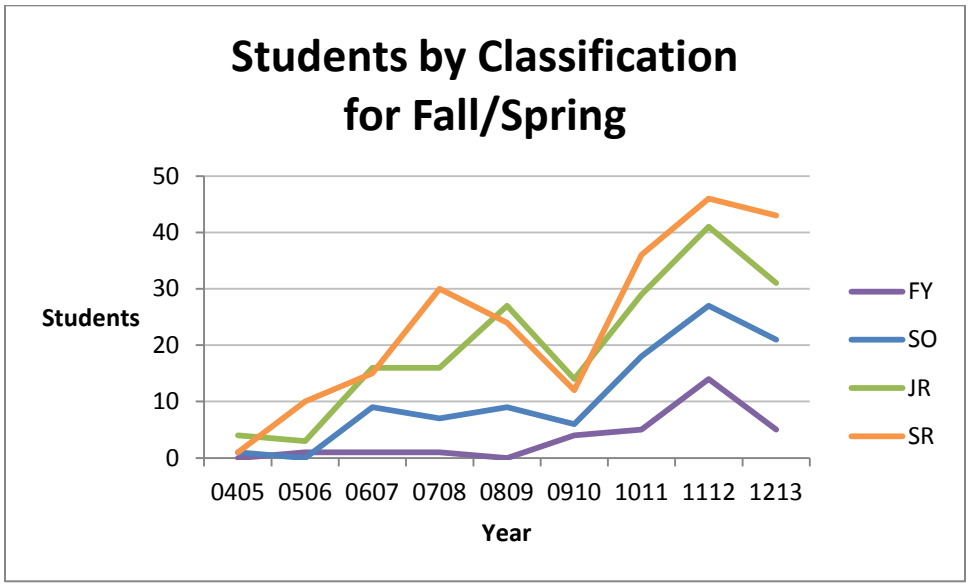
Minority participation has grown consistently over the past few years (Summer term findings are extremely similar). In fact, in the Fall/Spring 2012-13 term minority participators have actually overtaken white participators by a margin of 56-44.

Student Academic Life

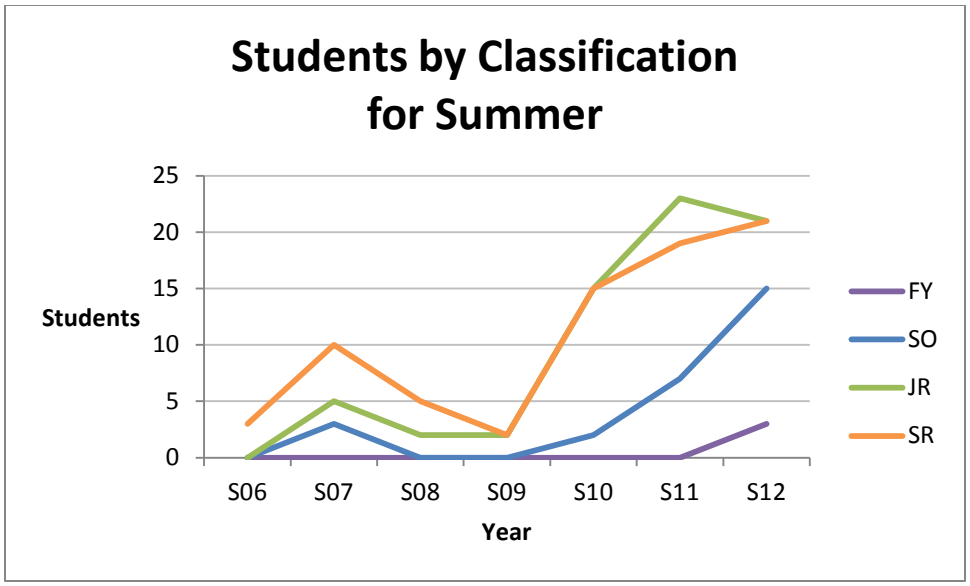
Distribution of Classifications

The first year of the URA program, all three participants were seniors. Since then, the participation rate of students of all classifications – first-years, sophomores, juniors, and seniors has risen. Historically, Summer/Fall term students have been 41% seniors, 35% juniors, 18% sophomores, and 6% freshmen.

However, we note a fairly recent shift in relative rates of participation. As seen below, initially most of the growth was concentrated in upperclassmen ranks. In recent years, however, participation by students of different classifications have moved together more evenly.



	0405	0506	0607	0708	0809	0910	1011	1112	1213	Total
FY	0	1	1	1	0	4	5	14	5	31
SO	1	0	9	7	9	6	18	27	21	98
JR	4	3	16	16	27	14	29	41	31	181
SR	1	10	15	30	24	12	36	46	43	217
Total	6	14	41	54	60	36	88	128	100	527

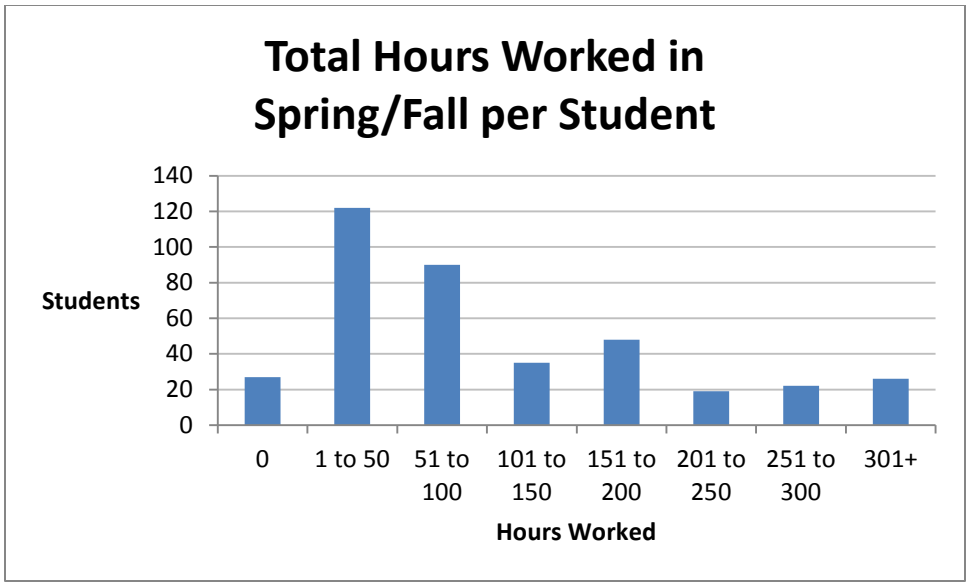


	S06	S07	S08	S09	S10	S11	S12	Total
FY	0	0	0	0	0	0	3	3
SO	0	3	0	0	2	7	15	27
JR	0	5	2	2	15	23	21	68
SR	3	10	5	2	15	19	21	75
Total	3	18	7	4	32	49	60	173

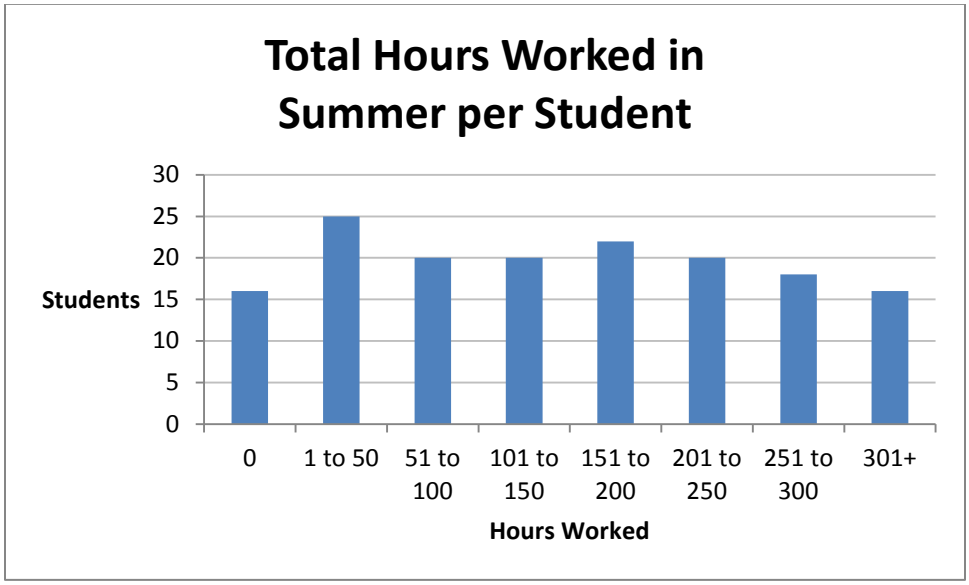
The Summer plots are, as usual, very similar. The most notable difference is that last year was the first to include freshman participation, with three first-years doing research over the summer. First-year summer participation is a new trend worth monitoring in the future.

Distribution of Hours Worked

This is one of the few areas where we notice a significant discrepancy between Fall/Spring and Summer students, with Summer students tending to work more hours. This data does not yet include numbers for the Fall/Spring 2012-13 term.

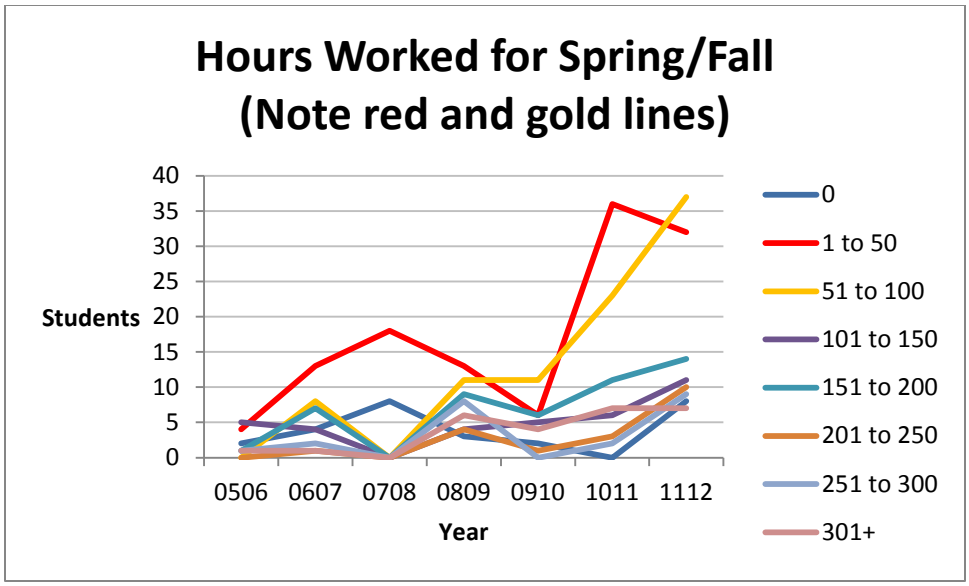


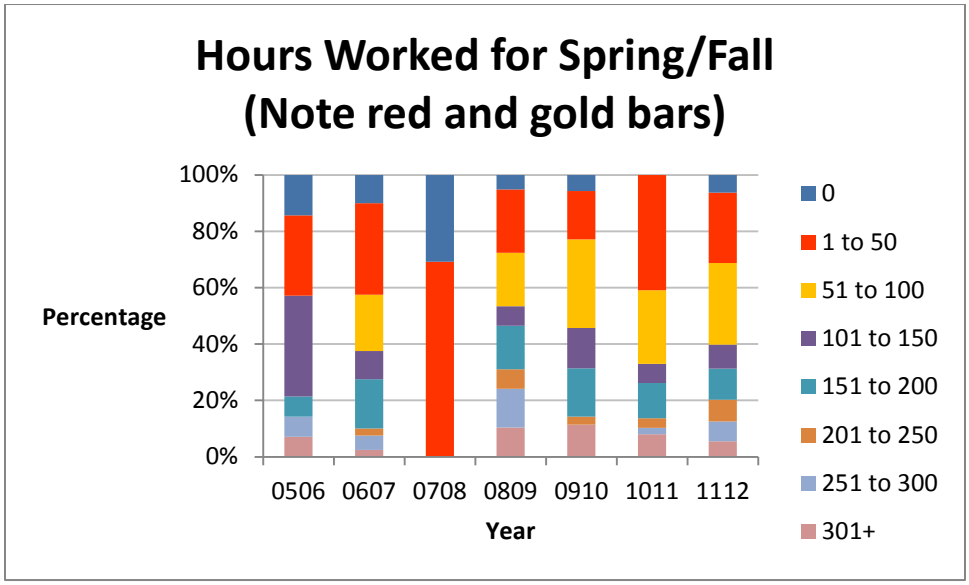
	0	1-50	51-100	101-150	151-200	201-250	251-300	301+
Students	27	122	90	35	48	19	22	26



	0	1-50	51-100	101-150	151-200	201-250	251-300	301+
Students	16	25	20	20	22	20	18	16

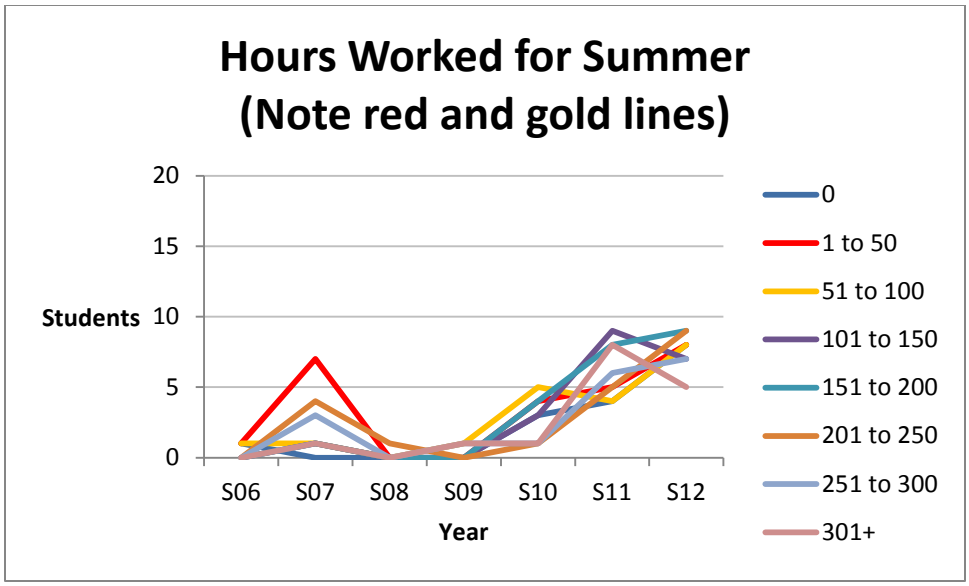
These proportions have remained fairly stable, but there is one exception: recent years have experienced a noticeable uptick in students working under 100 hours in the Fall/Spring.

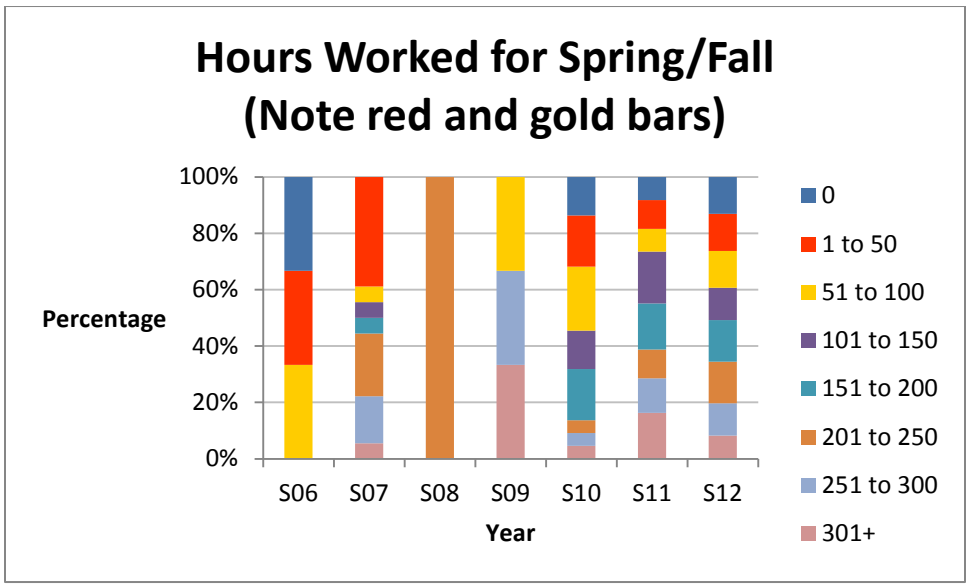




	0506	0607	0708	0809	0910	1011	1112	Total
0	2	4	8	3	2	0	8	27
1 to 50	4	13	18	13	6	**36**	**32**	122
51 to 100	0	8	0	11	11	**23**	**37**	90
101 to 150	5	4	0	4	5	6	11	35
151 to 200	1	7	0	9	6	11	14	48
201 to 250	0	1	0	4	1	3	10	19
251 to 300	1	2	0	8	0	2	9	22
301+	1	1	0	6	4	7	7	26
Total	14	40	26	58	35	88	128	389

This pattern is NOT mirrored in the Summer data.

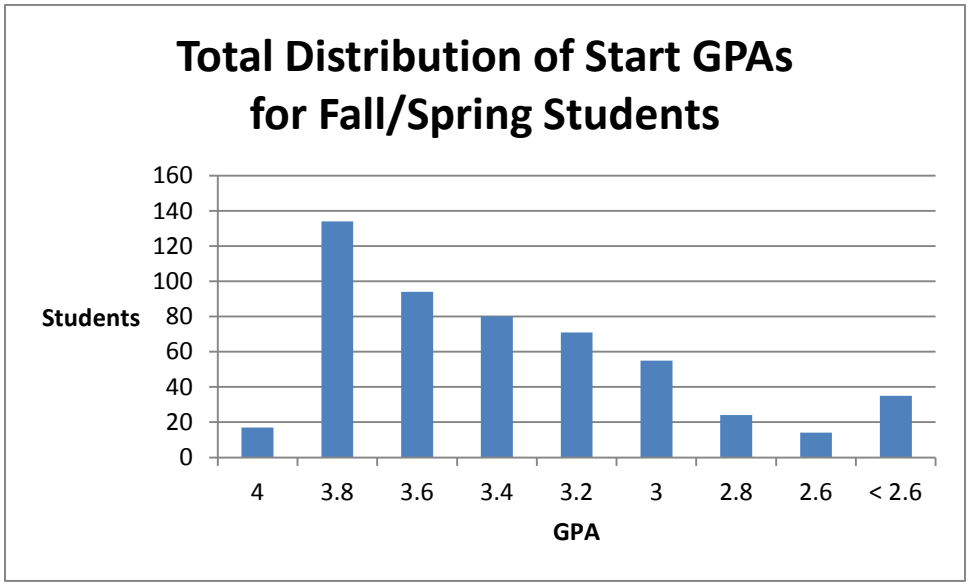




	S06	S07	S08	S09	S10	S11	S12	Total
0	1	0	0	0	3	4	8	16
1 to 50	1	7	0	0	4	5	8	25
51 to 100	1	1	0	1	5	4	8	20
101 to 150	0	1	0	0	3	9	7	20
151 to 200	0	1	0	0	4	8	9	22
201 to 250	0	4	1	0	1	5	9	20
251 to 300	0	3	0	1	1	6	7	18
301+	0	1	0	1	1	8	5	16
Total	3	18	1	3	22	49	61	157

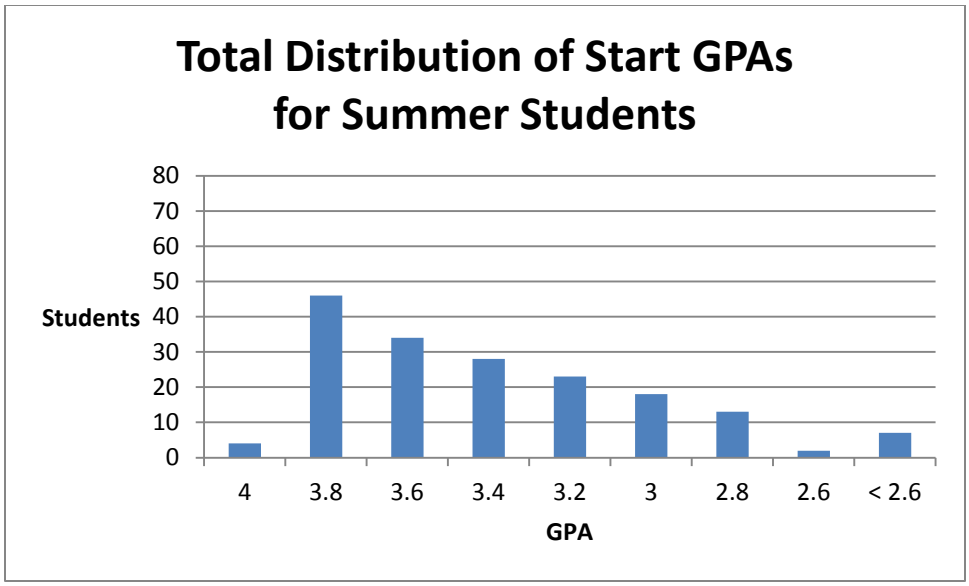
Distribution of GPAs

Historically, the distribution of student GPAs has been impressive, and quite similar between Spring/Fall and Summer students. Fully 85% of Fall/Spring and 87% of Summer students have had GPAs at or above 3.0, and 45% of Fall/Spring and 48% of Summer students have had GPAs at or above 3.6.



	0405	0506	0607	0708	0809	0910	1011	1112	1213	Total
4.0	0	0	0	3	2	3	4	1	4	17
3.8	2	4	10	7	19	7	28	28	29	134
3.6	3	6	9	6	10	6	12	24	18	94
3.4	1	3	6	12	6	7	12	18	15	80
3.2	0	0	6	8	13	7	9	16	12	71
3.0	0	1	3	10	2	3	10	16	10	55
2.8	0	0	3	2	4	2	5	6	2	24
2.6	0	0	1	4	1	0	1	3	4	14
< 2.6	0	0	3	2	3	1	7	16	3	35
Total	6	14	41	54	60	36	88	128	97	524

One trend is worth monitoring: half (16/32) of the students in the history of Fall/Spring term to have GPAs under 2.6 were enrolled in the 2011/12 term. Similarly, 3 out of 7 students in the history of the Summer term to have GPAs under 2.6 were enrolled in the Summer 2012 term. While GPA is not an all-encompassing measure of achievement, this might be somewhat concerning. On the other hand, the available data Fall/Spring 2012-13 shows that only three out of one hundred enrolled individuals have GPAs under 2.6.



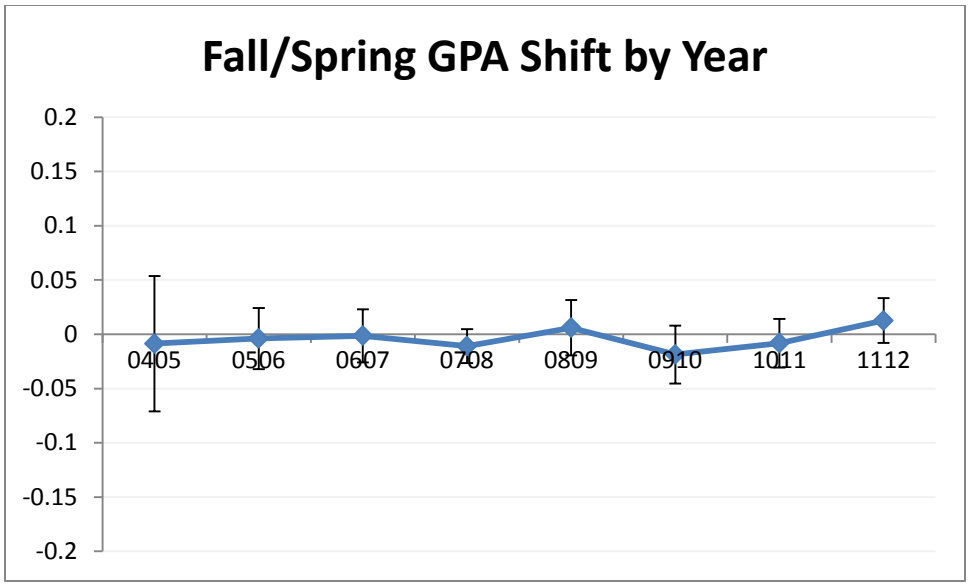
	S06	S07	S08	S09	S10	S11	S12	Total
4.0	0	1	0	0	1	0	2	4
3.8	0	3	0	1	8	10	24	46
3.6	1	3	1	1	2	15	11	34
3.4	1	3	1	0	4	6	13	28
3.2	1	2	2	1	4	9	4	23
3.0	0	3	1	0	8	5	1	18
2.8	0	2	1	1	3	3	3	13
2.6	0	1	1	0	0	0	0	2
< 2.6	0	0	0	1	2	1	3	7
Total	3	18	7	5	32	49	61	175

GPA Shift

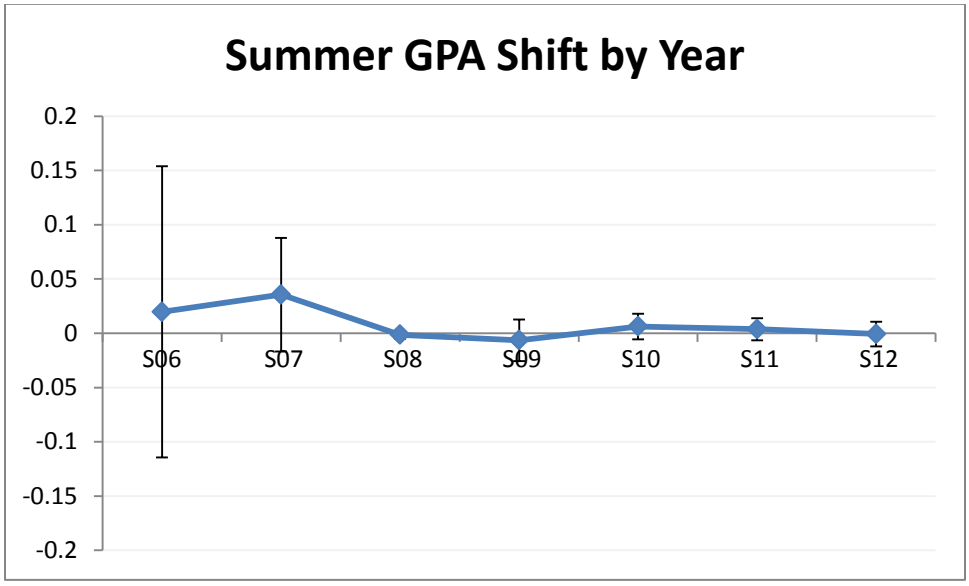
GPA Shift is defined by GPAend – GPAstart. If GPAend ≥ GPAstart, then we say the student's GPA has either risen or remained stable.

GPA Shift by Term

As shown below, mean GPA shift has remained stable at 0 for the entire history of both the Fall/Spring and Summer URA terms.



	0405	0506	0607	0708	0809	0910	1011	1112
avg	-0.0087	-0.0039	-0.0014	-0.0109	0.0060	-0.0186	-0.0082	0.0127
count	6	16	41	54	60	36	85	120
std error	0.0243	0.0133	0.0121	0.0078	0.0127	0.0131	0.0113	0.0104
T*	-2.57058	-2.13145	-2.02108	-2.00575	-2.001	-2.03011	-1.98861	-1.9801
error	0.0243	0.0133	0.0121	0.0078	0.0127	0.0131	0.0113	0.0104
LOWER	**-0.0711**	**-0.0322**	**-0.0258**	**-0.0266**	**-0.0195**	**-0.0452**	**-0.0307**	**-0.0080**
UPPER	**0.0538**	**0.0243**	**0.0230**	**0.0048**	**0.0314**	**0.0080**	**0.0142**	**0.0333**



	S06	S07	S08	S09	S10	S11	S12
avg	0.0197	0.0356	-0.0014	-0.0064	0.0063	0.0037	-0.0007

count	3	18	7	5	32	49	61
std error	0.0312	0.0248	0.0014	0.0069	0.0058	0.0050	0.0056
T*	-4.3027	-2.1098	-2.4469	-2.7764	-2.0395	-2.0106	-2.0003
error	-0.1341	-0.0523	-0.0035	-0.0192	-0.0118	-0.0101	-0.0113
LOWER	**-0.1144**	**-0.0168**	**-0.0049**	**-0.0256**	**-0.0055**	**-0.0064**	**-0.0120**
UPPER	**0.1538**	**0.0879**	**0.0021**	**0.0128**	**0.0181**	**0.0138**	**0.0106**

Of 336 students enrolling during the fall, 54% experienced their GPA either rise or remain stable.

Of 82 students enrolling during the spring, 67% experienced their GPA either rise or remain stable.

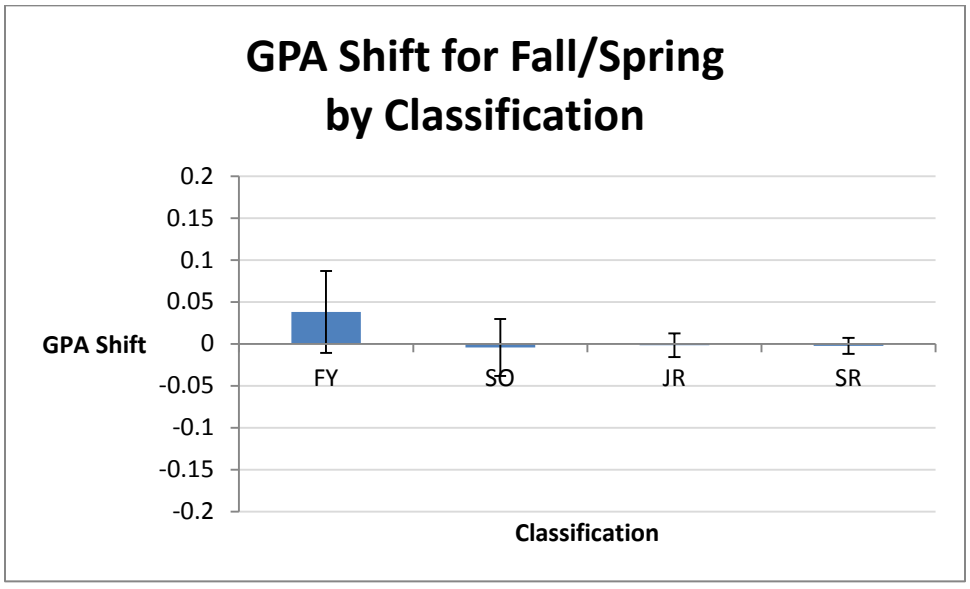
Of 175 students enrolling during the summer, 82% experienced their GPA either rise or remain stable.

Overall though, there is no evidence that mean GPA shift is different based on when people join.

We summarize by stating that 61% of URA students experience their GPA rise or remain stable.

GPA Shift by Classification

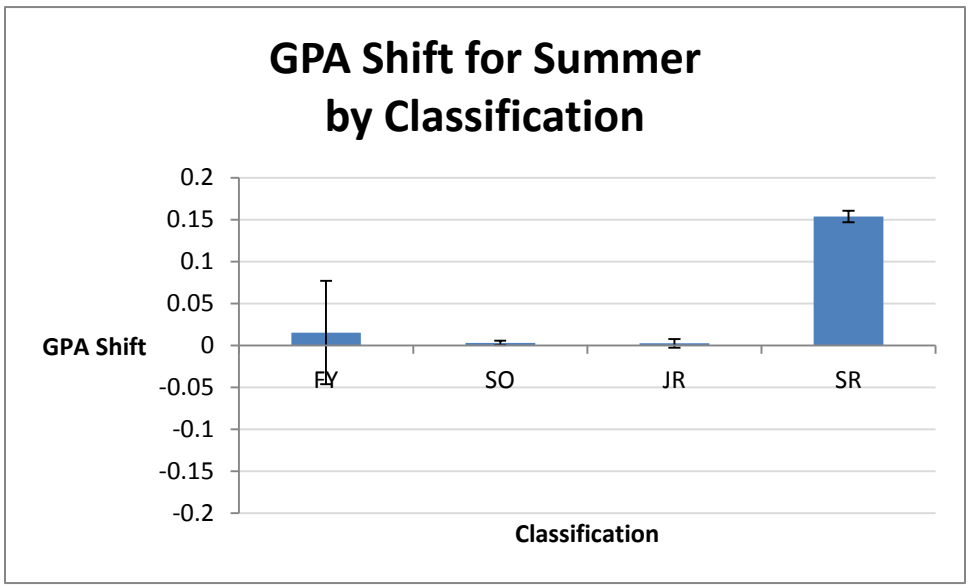
During Fall/Spring, there is no evidence that classification affects GPA shift. As shown below, there seems little reason to worry that hiring students too early in their careers will disrupt their academics.



	FY	SO	JR	SR
avg	0.0380	-0.0042	-0.0016	-0.0024
count	26	77	150	174
std error	0.0238	0.0170	0.0072	0.0048

T*	-2.0595	-1.9917	-1.9760	-1.9738
error	-0.0489	-0.0339	-0.0143	-0.0095
LOWER	**-0.0109**	**-0.0381**	**-0.0159**	**-0.0118**
UPPER	**0.0870**	**0.0297**	**0.0126**	**0.0071**

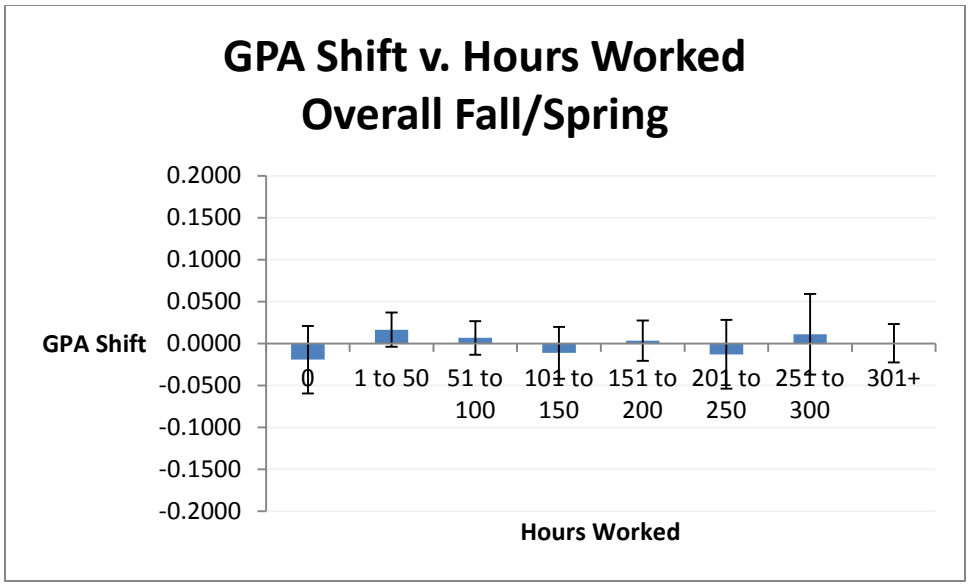
But during summer, there is significant evidence that seniors' GPA does best in summer, shifting by over 0.15 points on average. Note that there is some evidence of a sophomore bump that may be worth monitoring going forward, although I am inclined to view it as likely being a Type I error.



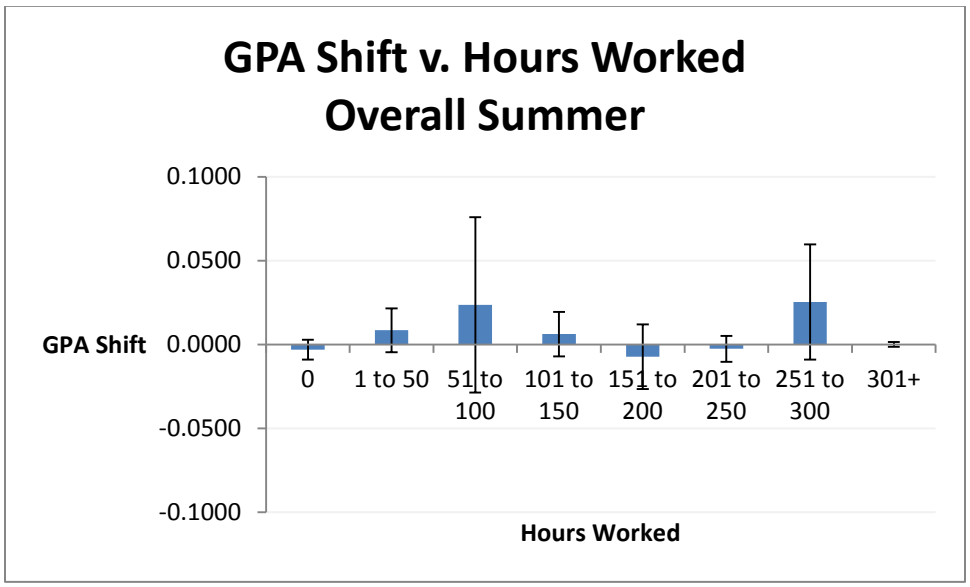
	FY	SO	JR	SR
avg	0.0153	0.0030	0.0024	0.1539
count	3	27	68	75
std error	0.0618	0.0026	0.0052	0.0069
T*	-4.3027	-2.0555	-1.9960	-1.9925
error	-0.2660	-0.0054	-0.0104	-0.0138
LOWER	**-0.0465**	**0.0004**	**-0.0028**	**0.1469**
UPPER	**0.0772**	**0.0056**	**0.0077**	**0.1608**

GPA Shift by Hours Worked

There is no evidence that for any amount of hours, either during Summer or Fall/Spring, GPA shift is other than zero. This finding has remained constant from year to year, statistical noise notwithstanding.



	0	1-50	51-100	101-150	151-200	201-250	251-300	301+	total
avg	-0.0193	0.0163	0.0066	-0.0111	0.0032	-0.0130	0.0111	0.0004	0.0047
count	27	122	90	35	48	19	22	26	389
std error	0.0221	0.0194	0.0268	0.0246	0.0145	0.0151	0.0461	0.0190	0.0055
T*	-2.0555	-1.9798	-1.9870	-2.0322	-2.0117	-2.1009	-2.0796	-2.0595	-1.9661
error	-0.0454	-0.0384	-0.0533	-0.0501	-0.0292	-0.0317	-0.0958	-0.0392	-0.0108
LOWER	**-0.0647**	**-0.0221**	**-0.0467**	**-0.0612**	**-0.0260**	**-0.0447**	**-0.0847**	**-0.0388**	**-0.0061**
UPPER	**0.0261**	**0.0548**	**0.0599**	**0.0389**	**0.0324**	**0.0187**	**0.1069**	**0.0395**	**0.0155**



	0	1-50	51-100	101-150	151-200	201-250	251-300	301+	total
avg	-0.0031	0.0084	0.0236	0.0062	-0.0074	-0.0026	0.0253	0.0000	0.0121

count	16	25	20	20	22	20	18	16	157
std error	0.0028	0.0063	0.0250	0.0064	0.0093	0.0037	0.0163	0.0007	0.0042
T*	-2.1314	-2.0639	-2.0930	-2.0930	-2.0796	-2.0930	-2.1098	-2.1314	-1.9753
error	-0.0059	-0.0131	-0.0523	-0.0134	-0.0193	-0.0077	-0.0343	-0.0014	-0.0082
LOWER	**-0.0090**	**-0.0046**	**-0.0287**	**-0.0072**	**-0.0267**	**-.0103**	**-0.0090**	**-0.0014**	**0.0038**
UPPER	**0.0028**	**0.0215**	**0.0759**	**0.0195**	**0.0120**	**0.0051**	**0.0596**	**0.0014**	**0.0203**

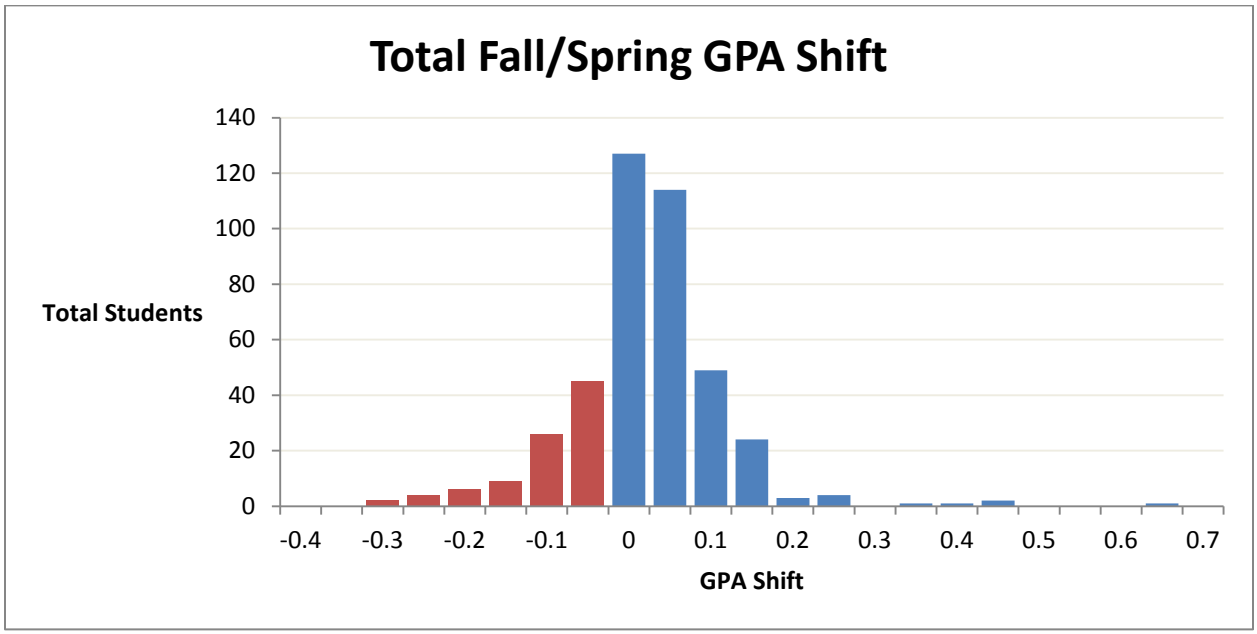
However, the 95% confidence interval for GPA shift in the summer does not include zero [95% CI: (0.0038,0.0203), n=157], so this is evidence that *overall*, mean GPA shift in the summer is positive. We hypothesize this is due to the unique GPA increases of seniors working during the summer, as previously discussed.

Distribution of GPA Shifts

Given the findings that a) mean GPA shift is 0, and b) over 60% of URA students experience raise or maintain their GPA, it is logical to worry that perhaps some minority of students is suffering serious GPA loss to offset more moderate GPA gains by the majority.

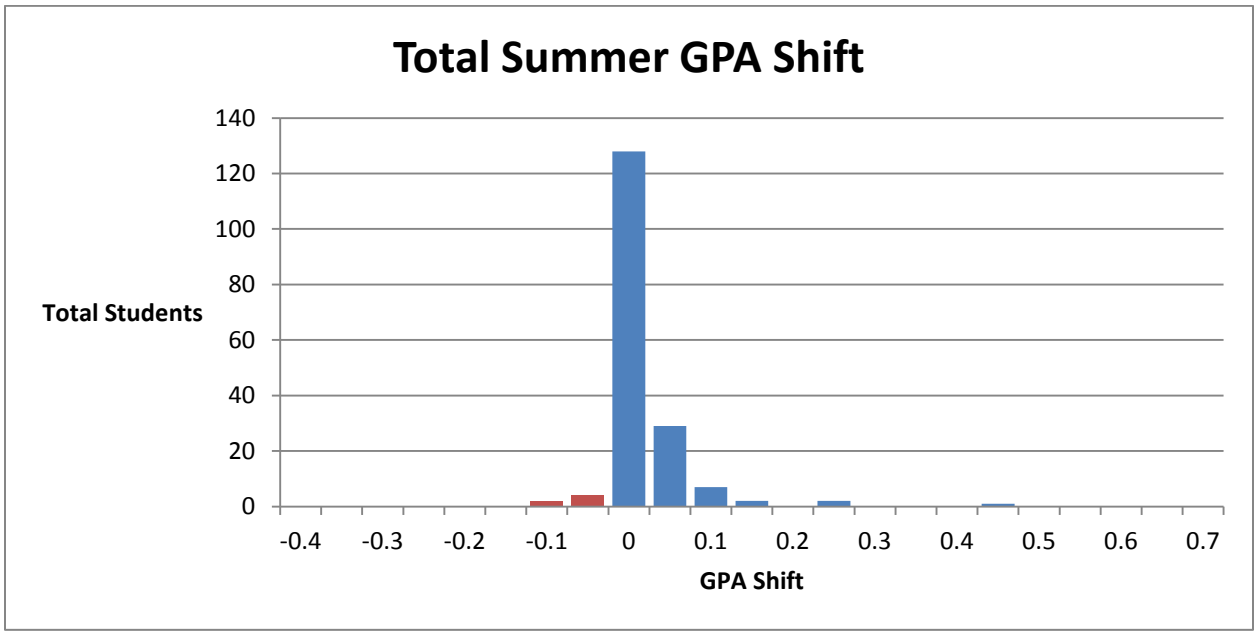
In reality, the distribution is actually fairly symmetrical, but shifted just above 0. This shift is not large enough to be statistically significant, but is large enough to give most students good GPA shift outcomes. In fact, rather than having a pattern of a few chronic sufferers of GPA shift, the most extreme outliers tend to benefit significantly, experiencing GPA gains as much as 0.3 points or higher.

These distributions have remained stable from year-to-year.



GPA	*Students*
-0.4	**0**

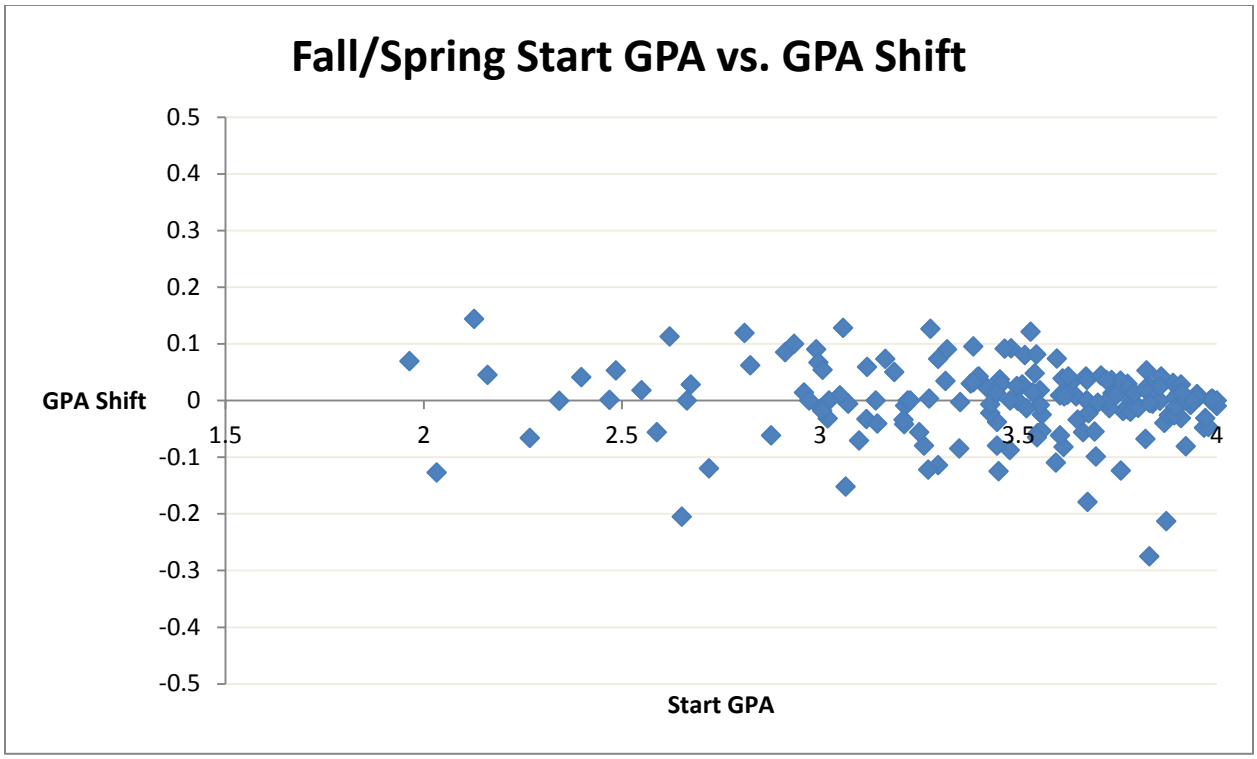
-0.35	**0**
-0.3	**2**
-0.25	**4**
-0.2	**6**
-0.15	**9**
-0.1	**26**
-0.05	**45**
0	**127**
0.05	**114**
0.1	**49**
0.15	**24**
0.2	**3**
0.25	**4**
0.3	**0**
0.35	**1**
0.4	**1**
0.45	**2**
0.5	**0**
0.55	**0**
0.6	**0**
0.65	**1**
0.7	**0**

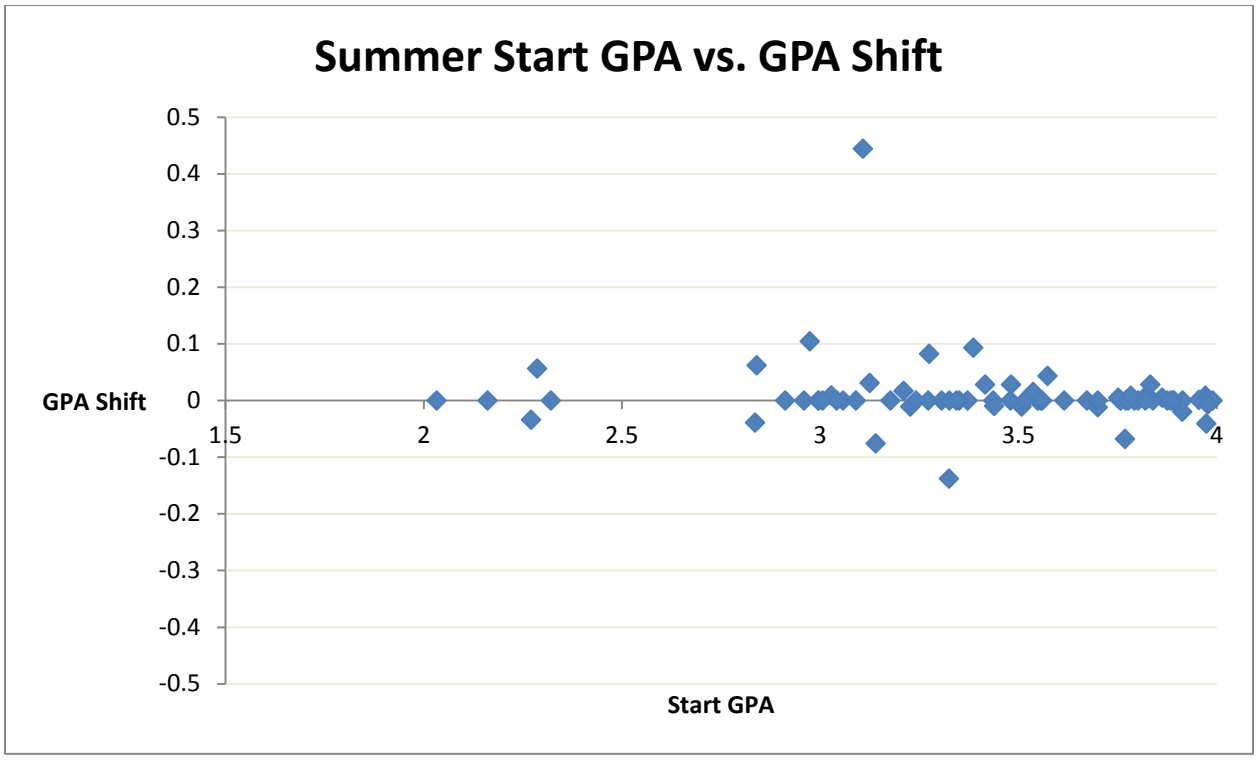


GPA	*Students*

-0.4	**0**
-0.35	**0**
-0.3	**0**
-0.25	**0**
-0.2	**0**
-0.15	**0**
-0.1	**2**
-0.05	**4**
0	**128**
0.05	**29**
0.1	**7**
0.15	**2**
0.2	**0**
0.25	**2**
0.3	**0**
0.35	**0**
0.4	**0**
0.45	**1**
0.5	**0**
0.55	**0**
0.6	**0**
0.65	**0**
0.7	**0**

We wanted to further investigate whether any relationship existed between Start GPA and GPA Shift. However, no pattern is apparent between the two. The correlations for regression slopes for Fall/Spring ($p=0.13$) and Summer ($p=0.32$) are both non-significant.


Fall/Spring Start GPA vs. GPA Shift
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
GPA Shift
1.5
2
2.5
3
3.5
4
Start GPA


Summer Start GPA vs. GPA Shift
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
GPA Shift
1.5
2
2.5
3
3.5
4
Start GPA

Students by School/Division

We will distinguish here between Schools/Divisions (Dedman I, Dedman II, Dedman III, Lyle, Cox, Meadows, and Simmons) individual Departments (Anthropology, Biology, Chemistry, etc.)

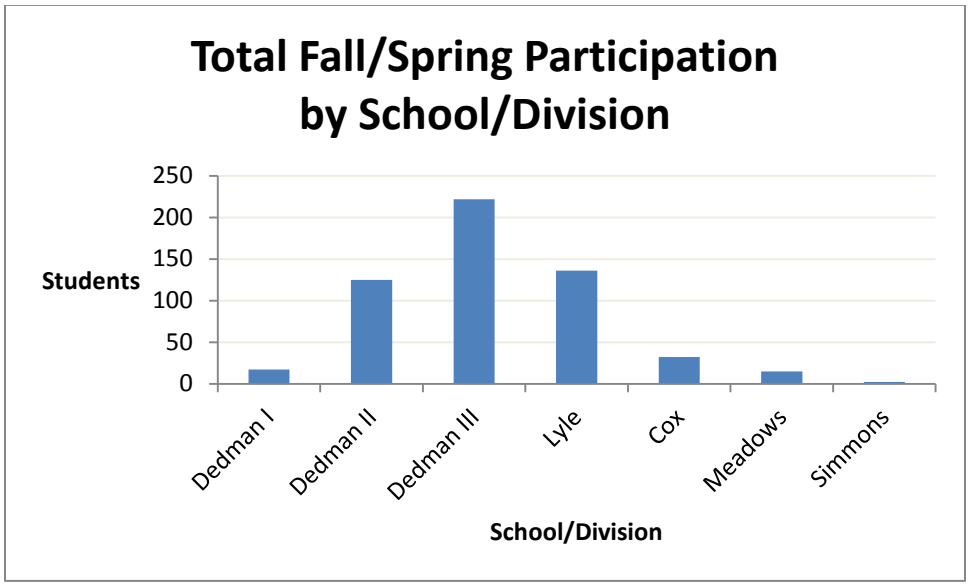
Unfortunately, information about specific URA departments students worked in was not available for several key years, during which the broad URA data suggests the program was actually at its most diverse. In particular, 2008-09, 2009-10, Summer 2008, and Summer 2009 do not have available data this specific. As such, the data regarding specific URA departments may be biased to exaggerate the dominance of Dedman III, Lyle, and Dedman II.

Note that the classification of Dedman I, II, and III was recently changed. All students in the data have been reclassified based on how they would *currently* be placed in Dedman, to permit consistency in cross-year comparisons.

NOTE: All data in this section will include data from the current year, 2012-13, as it is already freely available for analysis.

Students by School/Division

Historically, Spring/Fall terms have been dominated by Dedman III, followed by Lyle and Dedman II.

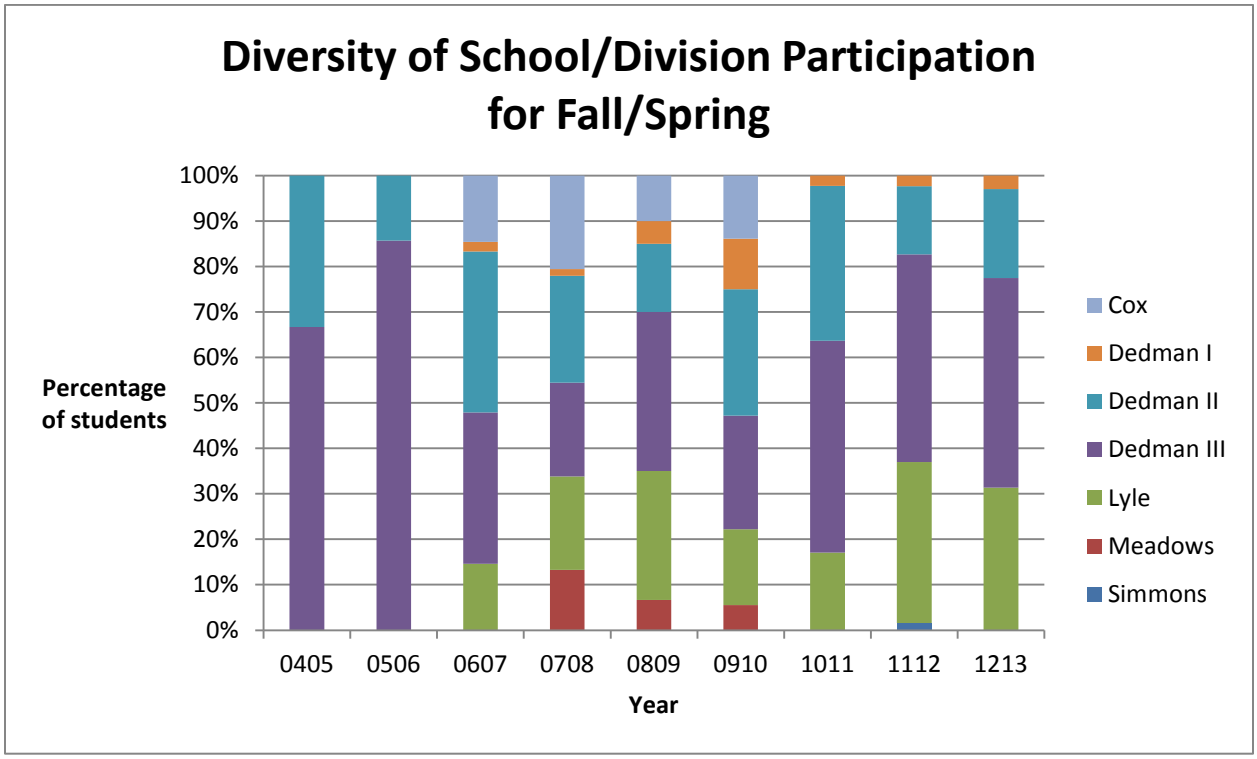


	TOTAL FALL/SPRING
Dedman I	17
Dedman II	125
Dedman III	222
Lyle	136
Cox	32

Meadows	15
Simmons	2

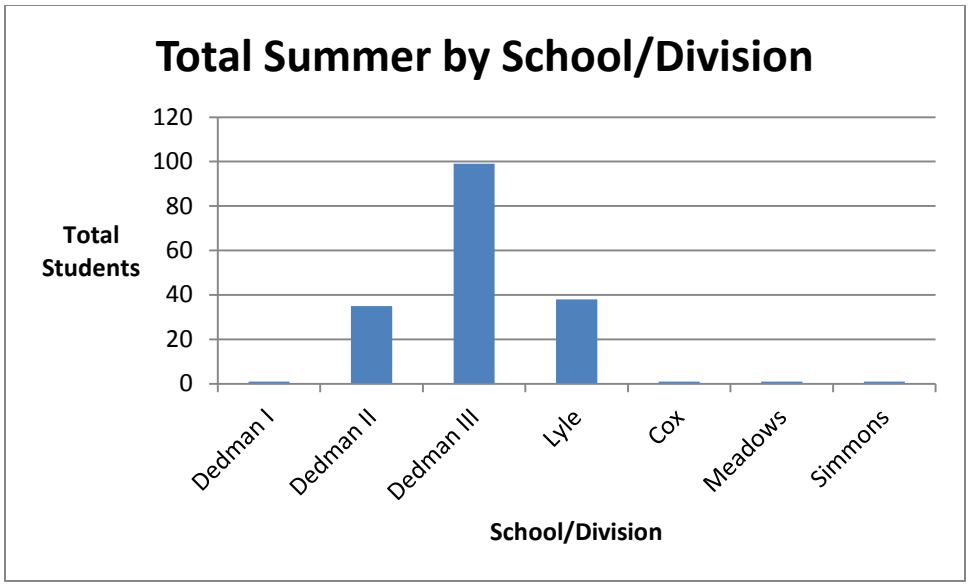
This distribution has remained quite stable in the past few years.

One potential concern is that there used to be far more diversity in the schools students were coming from. To demonstrate the sudden change, consider the graph below. Notice how much more evenly dispersed the different colors are from roughly 2007/08 until 2009/10.



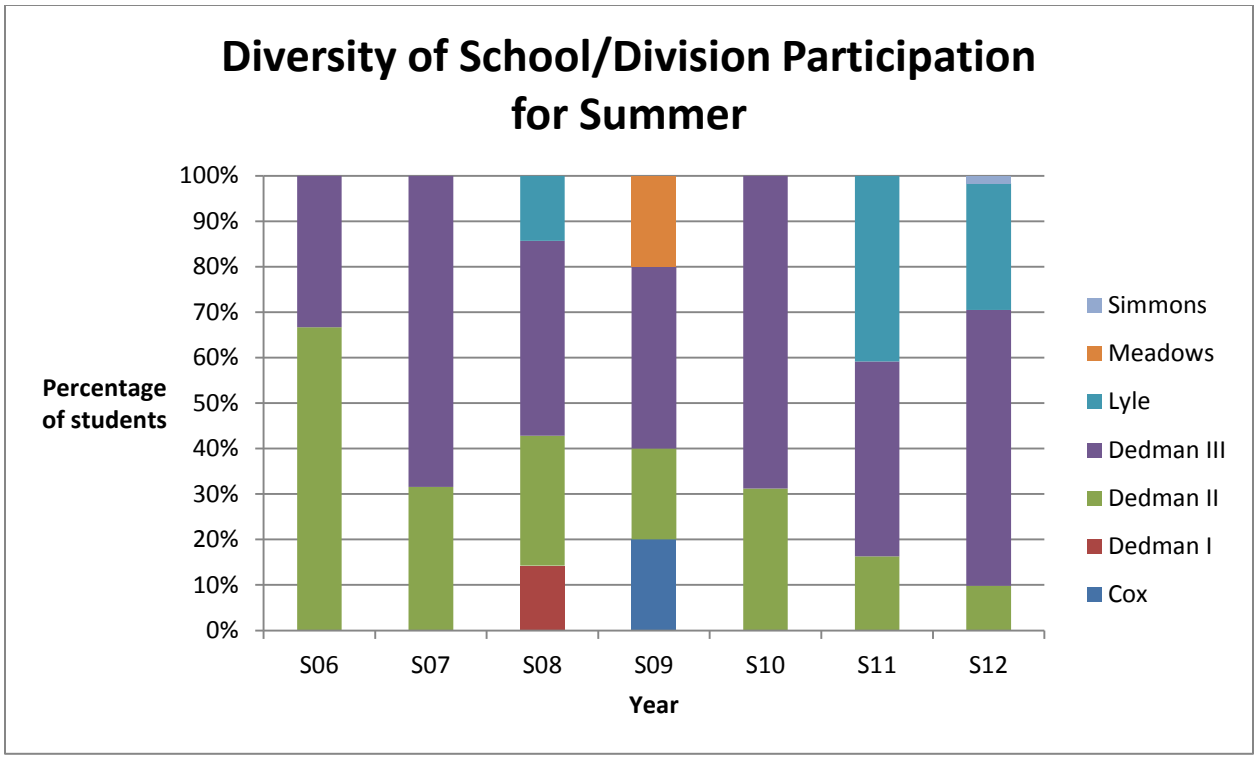
	0405	0506	0607	0708	0809	0910	1011	1112	1213
Cox	0	0	7	14	6	5	0	0	0
Dedman I	0	0	1	1	3	4	2	3	3
Dedman II	2	2	17	16	9	10	30	19	20
Dedman III	4	12	16	14	21	9	41	58	47
Lyle	0	0	7	14	17	6	15	45	32
Meadows	0	0	0	9	4	2	0	0	0
Simmons	0	0	0	0	0	0	0	2	0

This pattern of Dedman III, Lyle, and Dedman II dominating enrollment is even stronger in the summer, where only four students from other departments have been identified.



	TOTAL SUMMER
Dedman I	1
Dedman II	35
Dedman III	99
Lyle	38
Cox	1
Meadows	1
Simmons	1

Although the Summer term has smaller sample sizes overall, the Summer term shows a somewhat comparable shift.



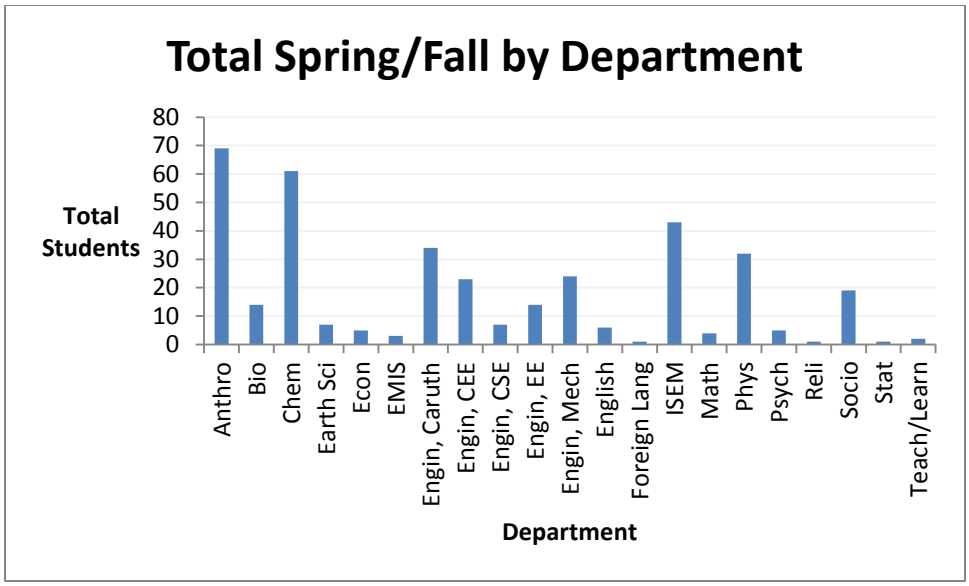
	S06	S07	S08	S09	S10	S11	S12
Cox	0	0	0	1	0	0	0
Dedman I	0	0	1	0	0	0	0
Dedman II	2	6	2	1	10	8	6
Dedman III	1	13	3	2	22	21	37
Lyle	0	0	1	0	0	20	17
Meadows	0	0	0	1	0	0	0
Simmons	0	0	0	0	0	0	1

It seems important to the goals of the URA program to ensure that a sufficient diversity of participating schools is maintained and encouraged.

Students by Department

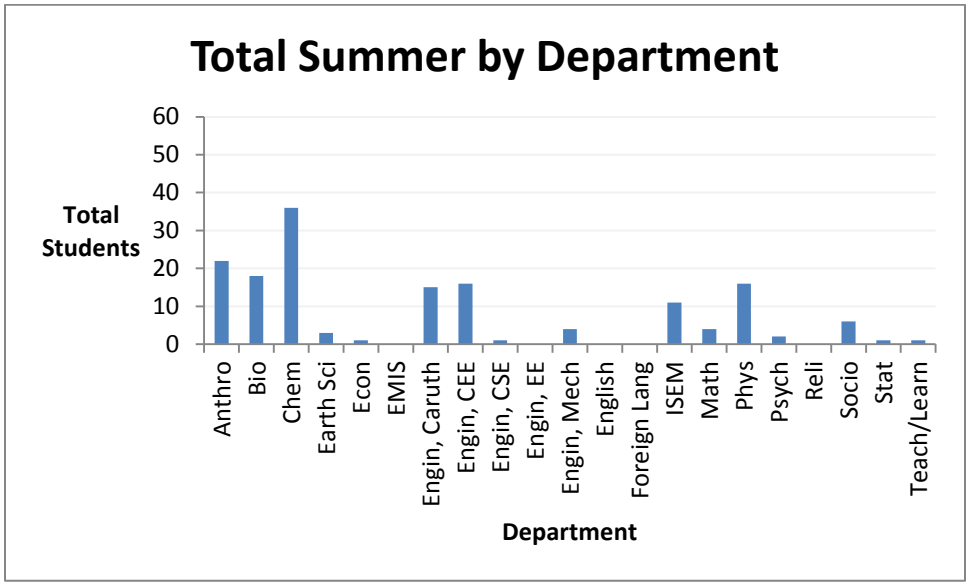
Here, we know to expect to see Dedman III, Lyle, and Dedman II dominate enrollment.

Historically, Anthropology and Chemistry have had the most students in the Fall/Spring, although the various Engineering departments, ISEM, Physics, and Sociology have also had many students.



This enrollment distribution has remained fairly stable in recorded years. Unfortunately, this data is not available for *precisely* those years where we saw more diversity in the School charts.

Summer enrollment has had a very similar distribution.



Again, the distribution is fairly similar from term to term.

	Total Fall/Spring	Total Summer
Anthro	69	22
Bio	14	18
Chem	61	36

Earth Sci	7	3
Econ	5	1
EMIS	3	0
Engin, Caruth	34	15
Engin, CEE	23	16
Engin, CSE	7	1
Engin, EE	14	0
Engin, Mech	24	4
English	6	0
Foreign Lang	1	0
ISEM	43	11
Math	4	4
Phys	32	16
Psych	5	2
Reli	1	0
Socio	19	6
Stat	1	1
Teach/Learn	2	1