

**Program Review Report
For
BS in Statistics
2005-06**

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Purpose

This report summarizes the strengths, weaknesses, needs and significant changes in the BS program in Statistics. In addition, we address undergraduate service course issues and summarize outcomes assessment process and results.

Strengths

The undergraduate statistics degree program is built upon existing service courses and mathematics courses. The only course that is an exception is the senior project which is typically handled as an independent study with a faculty member. Thus, offering this degree is relatively inexpensive.

The program follows the American Statistical Association guidelines for undergraduate degrees reasonably well (see Appendix 2 and weaknesses below).

Several of the graduates of the undergraduate statistics program have gone on to successfully complete graduate programs in statistics (Appendix 1).

Weaknesses

The number of undergraduate statistics majors (Appendix 5) and the number of graduates of this program (Appendix 7) have been low. This is not uncommon among undergraduate programs nationwide. Traditionally, graduate statistics programs have been the primary means of educating statisticians. While the American Statistical Association encourages academic members to implement undergraduate programs, most students first learn about the field of statistics late in their undergraduate program in some other field. Growing enrollment in high school AP statistics courses is slowly changing this trend. Two of three of our current statistics majors took AP statistics in high school. This is the first time we have had students with this background in our program.

Two required courses in the undergraduate statistics program, MATH 371, Probability, and MATH 408, Mathematical Statistics, are offered alternate years because enrollment does not indicate a need to offer them more often. As a result we commonly get one or two students that need these courses their senior year to graduate. Students also take their senior project at this time. To accommodate these students we offer these courses by individual study. This places an unusual teaching burden on the faculty member(s) responsible.

The statistics BS program follows the American Statistical Association undergraduate curriculum guidelines with respect to mathematical, computational (except data management), non-mathematical and substantive area requirements. However, we have a few missing areas in the statistical requirements. For example, required coursework (MATH 371, Probability, and MATH 408 Mathematical Statistics) provides a very good statistical theory foundation. However, Bayesian methods are typically not discussed in these courses and we have no elective in this area. Similarly, STAT 401, Regression and Analysis of Variance provides important statistical modeling background as required in the ASA guidelines but no required coursework includes data mining. The program is also somewhat deficient in statistical graphics and exploratory data analysis. Ideally the program would include coursework in these areas.

During the past five years we have had one faculty member retire and two faculty members left to take positions elsewhere. With only four statistics positions this is very high turn over. As a result we have had open positions during several search years. We have an additional faculty member joining the department in January 2006 and currently have a search on going to fill the fourth position.

Because we have had few graduates in this program, we have not taken outcomes assessment seriously. We keep undergraduate student projects and keep track of who graduated when but otherwise have little information about student learning in this program. The outcomes assessment plan for the undergraduate statistics program is provided in Appendix 4.

Needs

We need to recruit and retain well qualified statistics faculty.

An organized sustained student recruiting effort is needed. Historically students learned of the undergraduate statistics program by word of mouth or found it on the web. However, with more students coming out of high school AP statistics courses, we are beginning to see freshmen declaring statistics as their major for the first time. This program has the capacity for additional students. Thus, we should arrange to visit high schools offering AP Statistics to recruit students into this program.

We should find a way to bring the program closer to the ASA curriculum guidelines. This would require the addition of further elective courses. One way to achieve this may be to offer students the option of taking STAT 200 or STAT 300 in a web based format with required recitations run by teaching assistants. This would free up faculty members to teach elective courses. Publishers currently have web based materials available for STAT 200. We would have to check on the availability of such materials for STAT 300.

Recent Significant Changes

Because of large enrollments in STAT 300, Statistics, we changed the frequency of offering from each spring to each spring & alternate fall; effective spring 2004.

The frequency of offering, prerequisites, and description for STAT 480, Topics in Statistics, were changed effective fall 2002. The frequency of offering was changed from fall and spring to as demand warrants because open positions and sabbatical leaves among the four statistics positions made it difficult to offer this course regularly. The description was changed to allow the course to be repeated for credit if different topics are addressed. The prerequisite was changed from two STAT courses or permission to STAT 200 or STAT 300 and STAT 401 or equivalent to ensure that students were adequately prepared for the subject matter.

Biology and Wildlife used to allow their majors to choose between STAT 401, Regression and Analysis of Variance, and STAT 402, Sampling for their undergraduate programs. This past year they revised their curriculum so that STAT 402 is no longer an option. This lowered enrollment in this course from 30-40 down to 15 and increased enrollment in STAT 401 which has a required computer lab.

We have discussed but not implemented the following ideas for change: 1) make STAT 461, Applied Multivariate Statistics, a graduate course and make STAT 631, Distribution-free Statistics, an undergraduate course. Given the prerequisites for these two courses and their content, these changes seem appropriate.

Service Course Issues

Appendix 8 shows enrollment in undergraduate statistics courses. It is clear there are no under enrolled courses in our offerings except perhaps STAT 461, Applied Multivariate Analysis. We have discussed making this a graduate course to attract more graduate students from the sciences.

As noted above, growing enrollment in STAT 300 caused us to offer this course more frequently. CS students constitute the majority of the enrollment in this course and it appears likely their program will continue to grow in enrollment. Thus, it is important that we consider alternative means of offering this course such as the web based alternative mentioned above or offering it during summer session to allow statistics faculty to offer electives courses to our undergraduate and graduate students.

The Biology and Wildlife statistics requirement changes mentioned above resulted in decreased enrollment in STAT 402, Scientific Sampling and increased enrollment in STAT 401, Regression and Analysis of Variance. As a result of these changes and the limited size of our computer lab, we now offer two lab sections for STAT 401 rather than one. Because we typically try to move TAs to RA positions quickly to save the department money, faculty members often end up teaching these labs so the instructional burden is heavy with two 3-hour labs in addition to the normal two course teaching load.

Outcomes Assessment Summary

An outcomes assessment summary and assessment plan for the B.S. in Statistics are provided in Appendices 3 and 4 respectively.

The table below summarizes the information collected by year. As noted earlier, this program has relatively few graduates so little information has been collected.

	Academic Year				
	2000-2001	2001-02	2002-03	2003-04	2004-05
Assessment Information Collected	1 student project	1 student project	3 student projects & oral presentation	1 student project & oral presentation 1 student questionnaire	1 student project & oral presentation

Our assessment plan was revised in fall 2003 to include an omnibus test of student learning. However, this test has not been implemented to date. In addition, we have lost some collected assessment information due to faculty departures because there has not been a central store house. We have done a fair job of keeping track of program graduates and their employment and/or success in graduate school (Appendix 1), and have assessed student projects and related oral presentations (Appendix 4). We include copies of recent student projects after the appendices for your information. Overall, we

should be paying more attention to assessing learning outcomes of our graduates in this program and ensuring that information is not lost to faculty departures.

Who are our students? As part of this program review, we examined the transcripts of the 7 graduates of the B.S. Statistics program during the past five years to provide an overview of student characteristics. We offer the following summary of student characteristics:

- One student completed the Statistics program 20 years after completing a geology degree. All other statistics graduates were double majors; two in Biology/Wildlife and four in mathematics.
- Four graduates were male and three female.
- Three were from out of state and four from Alaska (one from outside Fairbanks area). These three each transferred a full academic year or more of credits from other institutions.
- Three graduates completed their degree program in four years, one in five years, one in six years, one in nine years, and the second degree student completed in 2 years. Time to graduation is longer than we would like but we expect this relates to students discovering statistics late in their academic career.
- Based upon their grades in statistics program required courses, there was no single course that appeared to be problematic; one student received a C grade in calculus II and one received a C in probability. Otherwise all earned A and B grades in all required courses. Grade point averages ranged from 3.23 to 3.80. Our impression is that we have attracted and graduated very good students in this program.

This summary provides us with further evidence that a better job of marketing our major may result in increased enrollment and may help shorten the time to graduation if we attract students earlier in their academic career.

Appendix 1 – List of BS Graduates by Year

- 1994 Michael Rosing, was enrolled as a student at the Center for Quantitative Ecology at the University of Washington after graduation, but we have lost track of him recently.
Jason Marshal, works as a wildlife biologist in Whitehorse, Yukon, Canada.
- 1995 Matt Clark, enrolled in an MS program at Washington State University, current whereabouts unknown. Had worked at an insurance company in Pullman, Washington
- 1996 Cameron Bird joined the Navy then went to medical school.
- 1997 Kate Heitkamp works for UAA in Anchorage, AK.
Lily Trofimovich, unknown
Kim Maki, works at UAF.
Robert Carroll, whereabouts unknown.
- 1998 Kevin Kacmarynski, completed an M.S. at Colorado State University and works for Hewlett-Packard in Corvallis, OR.
Don Benn became a School Teacher in Alaska.
Dave Vachitis, returned to the east coast for graduate school.
- 1999 Seth del'Isle works as a systems programmer.
- 2000 Venita DePuy vmdepuy@unity.ncsu.edu earned MS degree at North Carolina State University.
- 2001 Benjamin Venable, unknown.
- 2002 Jane Smith, administrative generalist, UAF Parking Services.
- 2003 Joseph Sepe, works for the National Security Agency in Maryland.
Erin Wahrenbrock, works as a local bartender.
Chris Johns finished his BS degree in summer 2002 (awarded in 2003); started an M.S. program in Statistics at Oregon State University fall 2002.
- 2004 Ryan Wilson, finished his BS degree in fall 2003. He plans to attend graduate school in Biology after a one semester break from college.
- 2005 Molissa Bifelt is pursuing a secondary teaching certificate.

Current undergraduate students

- Randy Peterson
- Jared Ingram
- John Fortner

Appendix 2

American Statistical Association

Curriculum Guidelines for Undergraduate Programs in Statistical Science

Copied from http://www.amstat.org/education/index.cfm?pf=Curriculum_Guidelines&fuseaction=Curriculum_Guidelines

The American Statistical Association endorses the value of undergraduate programs in statistical science, both for statistical science majors and for students in other majors seeking a minor or concentration. This document provides guidelines for development of curricula for such programs.

Principles

Undergraduate programs in statistics are intended to equip students with quantitative skills that they can employ and build on in flexible ways. Some students will plan graduate work in statistics or other fields, while others will seek employment after their first degree. Programs should be sufficiently flexible to accommodate varying goals. Undergraduate programs are not intended to train professional statisticians, though some graduates may reach this level through work experience and/or further study.

Institutions vary greatly in the type and intensity of programs they are able to offer. The ASA believes that almost all institutions can provide a level of statistical education that is useful to both students and employers. We encourage flexibility in adapting these guidelines to institutional constraints. In many cases, statistics minors or concentrations for quantitatively oriented students in fields such as biology, business, and behavioral and social science may be more feasible than a full statistics major.

Undergraduate statistics programs should emphasize concepts and tools for working with data and provide experience in designing data collection and in analyzing real data that go beyond the content of a first course in statistical methods. The detailed statistical content may vary, and may be accompanied by varying levels of study in computing, mathematics, and a field of application.

Though statistics requires mathematics for the development of its underlying theory, statistics is distinct from mathematics and uses many non-mathematical skills; thus, the curriculum *must* be more than a sequence of mathematics courses. It is essential that faculty trained in statistics and experienced in working with data be involved in developing statistics programs and in teaching or supervising courses required by the programs.

Skills Needed

Effective statisticians at any level display a combination of skills that are not exclusively mathematical. Programs should provide some background in these areas:

- **Statistical** - Graduates should have training and experience in statistical reasoning, in designing studies (including practical aspects), in exploratory analysis of data by graphical and other means, and in a variety of formal inference procedures.
- **Mathematical** - Undergraduate major programs should include study of probability and statistical theory along with the prerequisite mathematics, especially calculus and linear algebra. Programs for non-majors may require less study of mathematics. Programs preparing for graduate work may require additional mathematics.
- **Computational** - Working with data requires more than basic computing skills. Programs should require familiarity with a standard statistical software package and should encourage study of data management and algorithmic problem-solving.
- **Non-mathematical** - Graduates should be expected to write clearly, to speak fluently, and to have developed skills in collaboration and teamwork and in organizing and managing projects. Academic programs often fail to offer adequate preparation in these areas.
- **Substantive area** - Because statistics is a methodological discipline, statistics programs should include some depth in an area of application.

Curriculum Topics for Undergraduate Degrees in Statistical Science

The approach to teaching the following topics should:

- Emphasize **real data** and authentic applications.
- Present data in a context that is both meaningful to students and indicative of the science behind the data.
- Include experience with **statistical computing**.
- Encourage **synthesis** of theory, methods, and applications.
- Offer frequent opportunities to develop **communication** skills.

Statistical Topics

- Statistical theory (e.g., distributions of random variables, point and interval estimation, hypothesis testing, Bayesian methods).
- Graphical data analysis methods.
- Statistical modeling (e.g., simple, multiple, and logistic regression; categorical data; diagnostics; data mining).
- Design of studies (e.g., random assignment, replication, blocking, analysis of variance, fixed and random effects, diagnostics in experiments; random sampling, stratification in sample surveys; data exploration in observational studies).

Mathematical Topics

- Calculus (integration and differentiation) through multivariable calculus.
- Applied linear algebra (emphasis on matrix manipulations, linear transformations, projections in Euclidean space, eigenvalue/eigenvector decomposition and singular-value decomposition).

Probability

- Emphasis on connections between concepts and their applications in statistics.

Computational Topics

- Programming concepts; data base concepts and technology.
- Professional statistical software appropriate to a variety of tasks.

Non-Mathematical Topics

- Effective technical writing and presentations.
- Teamwork and collaboration.
- Planning for data collection.
- Data management.

Electives- There are many electives that might be included in a statistics major. Since resources will vary among institutions, the identification of what will be offered is left to the discretion of individual units.

Practice - When possible, the undergraduate experience should include an internship, a senior-level "capstone" course, a consulting experience of some kind, or a combination of these. These and other opportunities to practice statistics should be included in a variety of venues in an undergraduate program.

Curriculum Topics for Minors or Concentrations in Statistical Science

The core of a minor or concentration in statistics should consist of:

- General statistical methodology (statistical thinking, descriptive, estimation, testing, etc.);
- Statistical modeling (simple and multiple regression, diagnostics, etc.);
- Exposure to professional statistical software.

The number of credit hours for minors or concentrations will depend on the policies set by the academic units involved. Additional topics to complete the required number of credit hours could be chosen from some non-exhaustive list (e.g., mathematical statistics, design of experiments, categorical data analysis, time series, Bayesian methods, probability, database management, a capstone experience). Courses from other

departments with significant statistical content might be allowed to count toward a statistics minor or concentration, though the content of such courses must differ substantially from the others.

Additional Information

The ASA's Center for Statistical Education (see www.amstat.org) has available more detailed recommendations on statistics programs, along with a list of model programs. These materials have been developed and are maintained by the Section on Statistical Education, in conjunction with other sections and committees of ASA. Those considering new or revised undergraduate statistics programs may contact the Center for Statistical Education for further information.

Appendix 3 - Statistics B.S. Assessment Summary

Assessment Criteria	Implementation	Conclusions Drawn	Curricular or assessment changes
1) An omnibus test addressing students analytical and SAS programming abilities will be administered during their senior project course.	1) This test has not been written and so no data of this kind has been collected.	None	none
2) Portfolio of SAS use from STAT 401.	2) All our undergraduates take STAT 401 and use SAS for analysis. In addition, all student projects except one have used SAS for their analyses. Thus, we have good evidence they know how to use SAS when they complete their degree.	We have good evidence our graduates know how to use SAS when they complete their degree.	none
3) Written and oral presentation of Senior Project.	3) Each student has given an oral presentation of their senior project and a written report. We have maintained copies of all but two of these reports. These two were handled by faculty members who left the department and we did not get copies of these reports before their departure.	Student projects are well written and the quality of oral presentations, including the use of PowerPoint, has been very good.	We will require that pdf copies of student projects are posted to the department web site so that faculty departures do not result in lost assessment information.
4. a. Alumni survey b. Employment/graduate school attendance records	a. Program graduates were asked to complete graduation surveys. However, all but one of the responses was lost due to a faculty departure. b. We have done our best to keep track of our graduates but find this challenging.	a. With only one response to work with, we are reluctant to draw conclusions. Our one response indicated we should bring stat computing earlier in the curriculum. b. none	a.-We need to make sure graduate questionnaires are kept by the department staff rather than faculty. b. We need to see if we can keep track of graduates and their careers better.

Appendix 4 –Statistics BS Outcomes Assessment Plan

Expanded Statement of Institutional Purpose	Intended Outcomes/Objectives	Assessment Criteria and Procedures	Implementation
<p>1. To introduce students to fundamentals of theoretical and applied statistics (Outcomes Assessment 1-4)</p>	<ol style="list-style-type: none"> 1. Graduates shall be able to identify and use probability models for deriving and assessing the characteristics of estimators and deriving and assessing the quality of hypothesis tests. 2. Graduates shall be able to perform basic statistical analyses including descriptive statistics, basic contingency table results, one-way ANOVA, simple and multiple regression analysis. 	<p>An omnibus test addressing students analytical and SAS programming abilities will be administered during their senior project course. As no national test, like the ETS major field test, is available, we will write our own test. The test will include questions on basic descriptive statistics, probability (including marginal, conditional and joint distributions), expectation and variance, estimators and their properties, theory of hypothesis testing, and applications including regression, contingency tables, and one-way ANOVA.</p>	<p>Review of omnibus test responses by Statistics faculty in May of each year</p>

Expanded Statement of Institutional Purpose	Intended Outcomes/Objectives	Assessment Criteria and Procedures	Implementation
	3. Graduates shall be able to use the SAS statistical computing package for statistical methods represented in outcomes 1 & 2.	Portfolio of SAS use from STAT 401.	Statistics faculty review SAS portfolios each May.
	4. Graduates shall be able to effectively communicate statistical concepts and results in written and oral settings.	Written and oral presentation of Senior Project.	A collection of Statistics faculty shall attend Senior project presentations, read the written project report, and summarize their findings.
To prepare students for employment as a statistical technician or for entrance into graduate school (Outcomes Assessment 5)	5. Graduates shall be well qualified to serve as statistical technicians or to enter graduate programs in Statistics or their field of application.	a. Graduate survey b. Employment/graduate school attendance records.	Compile information on jobs and graduate school attendance by our graduates. Records of informal inquiries of employers will be kept. Survey results from Career Services will be summarized. The faculty will review this input annually.

Appendix 5 – Headcount of Majors By Year

UAF Program Review 2005-06
College of Natural Science and Mathematics
Headcount of Majors

Department	Major	Degree	Fall	Spring	Fiscal Year	Fall	Spring	Fiscal Year	Fall	Spring	Fiscal Year	Fall	Spring	Fiscal Year	Fall	Spring	Fiscal Year	
			2000	2001	2001	2001	2002	2002	2003	2003	2004	2004	2005					
CNSM Mathematical Sciences	Mathematics	BA	5	6	6	7	7	9	4	5	6	9	6	9	5	4	7	
		BS	25	24	36	28	35	36	39	38	45	38	41	37	38	42		
		MS	4	6	6	6	7	8	6	3	8	2	4	5	5	6		
		PHD	1		1			1	2	2	4	3	5	6	5	6		
	Statistics	BS	2	2	2	1		1	1		1	1	1	1	1	1	1	
		MS				4	5	7	9	9	10	4	5	8	4	5	5	
	Premajor - Mathematics	BI													2	2	3	
	Premajor - Statistics	BI										1	1	1	1	1		
	CNSM Mathematical Sciences Total			37	38	49	44	55	61	60	58	72	53	52	69	58	59	69

Appendix 6 – Student Credit Hours By Year

UAF Program Review 2005-06
College of Natural Science and
Mathematics
Student Credit Hours without audited
hours

				Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring			
				2000	2001	2002	2001	2002	2002	2002	2003	2003	2003	2004	2004	2004	2004	2005		
Department	Subject	Subject_Description	Level																	
Department CNSM Mathematical Sciences	MATH	Mathematics	LD	2,585	2,581	2,585	2,725	2,802	2,725	2,784	2,898	2,855	2,888	2,593	2,587	2,766	2,475			
			UD	425	358	425	405	313	425	473	443	367	485	483	405	626	539			
			GR	56	83	56	67	89	56	59	59	103	54	103	54	74	125			
	STAT	Statistics	LD	312	363	312	300	336	312	312	372	351	372	369	312	369	312	369		
			UD	155	208	155	125	263	155	216	227	136	136	290	172	248				
			GR	66	88	66	60	85	66	66	69	57	82	62	62	67				
	Total CNSM Mathematic Sciences				3,599	3,769	3,599	3,682	3,888	3,700	3,910	4,000	3,735	4,169	3,859	4,012	3,900			

Appendix 7 – Degrees Awarded By Year

UAF Program Review 2005-06
College of Natural Science and Mathematics
Degrees Awarded

Department	Degree	Major_Description	1999	2000	2001	2002	2003	2004	2005
CNSM Mathematical Sciences	BA	Mathematics			1		1	1	2
	BS	Mathematics	5	8	8	3	9	10	8
		Statistics	1	1	1	1	1	1	
	MS	Mathematics	1				4	1	2
		Statistics				1	3	5	1
CNSM Mathematical Sciences Total			7	9	10	5	18	18	13

Appendix 8 – Course Enrollment by Year

Statistics Course Enrollment (sections; J = Juneau) by semester 2000-2005

STAT	Fall 2000	Spring 2001	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005
200	104(2)	122(2)	101(2)	114(2)	104(2)	124(2)	125(2)	123(2)	104(2)	123(2)	106(2)
300		42✓		46✓		41✓		47✓		44✓	31✓
401	16✓	19✓	17✓	19✓	34✓	27	19✓	36✓	31✓	28✓	27
402	29		20✓		28		20✓		16✓		15✓
461				12✓				7✓			
480			canceled	10✓							
602	11				9				11		
605				13				11			
611		6				13				12	
621				2				4			
631			12				11				8
651	6		7		6		6		7		6
652		7				7				6	
653				9				8			
654		5				7		1		1	
661		2									10(J)