

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

### PROGRAM PRODUCTIVITY AND EFFICIENCY

1) Discuss or provide context for the following components of the PAIR data, and provide an explanation of any numbers that may seem out of place given the size and capacity of your program:

- a. Total SCH
- b. Number of majors
- c. Number of degrees
- d. Time to degree
- e. Department budget
- f. FTEs

If the data do not accurately reflect the program, explain why not. Also, discuss trends, e.g., is enrollment growing or decreasing? Why?

In the previous program review year (2014-2015), the Department of Mathematics and Statistics (DMS) prepared an extensive program review for the BS and BA programs. The current document uses the more recent, and more accurate, PAIR data for the MS Mathematics program. Nonetheless, the current document re-uses some content from the previous program review because many distinctive features of DMS have not changed.

#### Total SCH

The student credit hours (SCH) of "MATH - Grad" courses listed in the current (dated 11/5/15) PAIR data is spread over a number MATH 600-level courses. From the point of view of the MS Mathematics curriculum, these courses are in two types: required courses and service/elective courses.

On a two-year cycle we teach four courses required of all MS Mathematics students:

- MATH 631 Algebra I
- MATH 641 Real Analysis
- MATH 645 Complex Analysis
- MATH 651 Topology

These courses are taken by MS Math and PhD Math students almost exclusively, with roughly 90% of these being from the MS program.

Most remaining MATH 600-level courses, especially

- MATH/PHYS 611, 612 Mathematical Physics I, II
- MATH 614 Numerical Linear Algebra
- MATH 615 Numerical Analysis of Differential Equations
- MATH 660 Advanced Mathematical Modeling

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

- MATH 663 Graph Theory

are significantly "service" courses with students from other majors including the sciences, engineering, computer science, and statistics. Though the fraction of "MATH Grad" SCH which actually represents students of the MS Math program is unknown in the PAIR data, that fraction is between 50% and 75% for these elective/service courses. Thus the number of MS Math SCH is more likely to be 100 per year than the 145.6 SCH average per year for "Math - Grad" SCH. Also, MS Mathematics students take some 400-level MATH courses, but this is at the 5% to 15% level of the 600-level course SCH.

In summary:

- About 2/3 of graduate MATH course offerings appeal to students in other graduate programs.
- About 1/3 of our "MATH-Grad" SCH are supporting other graduate programs.

### Number of majors

The numbers of majors reported in the PAIR data are reasonable compared to our record-keeping (though the exact PAIR query is unknown).

However, roughly 50% of our students, including many listed as current majors, are unfunded. Such students are likely to have been accepted based on adequate credentials (undergraduate course preparation, grades, GRE scores, and letters of recommendation) which are, however, not competitive with the students who are offered funding at admission. Unfunded students are likely to take much longer to graduate as they are generally employed elsewhere in Fairbanks, often full-time. They are unlikely to sustain the 9-10 credits per semester required to graduate in two years, as required of Teaching Assistants. This reduced load taken by unfunded students is strongly reflected in the "Majors' Average Annual SCH Load".

Almost all funded majors are in Teaching Assistantships (TAs) and thus they contribute significantly to DMS's undergraduate teaching. Roughly 5 TAs are awarded each year for MS Math students in the review period. Their TA responsibilities include serving as graders, recitation (section) instructors, and lead teachers. They cover an important fraction, though probably under 10%, of the "MATH-Lower" and "MATH-Outside" SCH delivered by the Department.

It takes some students more than two years to graduate, especially those who are not funded by the Department. While the average number of new MS Mathematics students (new admission and attendance) is about 5 or 6 per year, about 2 students per year drop out due to personal reasons, poor performance, or switching to another major.

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

Thus our graduation rate is above 50%, but it is more like 70% for funded students, which we believe is a healthy number as we maintain high standards and rigorous requirements. (Yes, students do fail their Comprehensive exams; over time at a rate of 10-20%.)

The Department could sustain a larger graduate program but the number of TA positions is limited. Research funding is also quite limited *nationwide* for mathematics research---but see below for our faculty's results---and this is reflected in the low and sporadic ability of the mathematics faculty to support MS Mathematics students through Research Assistantships. In fact students have only been supported by RAs through grants which are strongly applied in focus (e.g. geophysics and biology faculty collaborations).

### Number of degrees

The number of degrees reported in the PAIR data is accurate compared to our record-keeping. We believe that two students graduated in 2011, but that difference may be an artifact of the timing of the start of the fiscal year.

### Time to degree

As an indirect measure of "time to degree" we may use the "Majors/Degrees" reported on the recent PAIR data. (No "time to degree" is directly reported.) We believe the high value of 5.6 is largely explained by unfunded students who make slow progress.

If we recompute as "*(Funded Majors)/Degrees*" for FY11-FY15, using 5 TAs/year for MS students as above, the number would be  $25/9 = 2.8$ , which is more in line with our experience that funded MS Mathematics students complete the degree in two years, though often with a summer or extra semester devoted to project/thesis completion.

### Department Budget

As reported by the CNSM Dean, the total Department budget for FY11-FY15 is \$2,035,586 average per year. The fraction of this budget spent on teaching and supervision of MS Mathematics students is, however, quite small. As an estimate based on SCH, using the FY11-FY15 totals of "MATH - Grad" divided by the total DMS SCH, we get 1.4% of the budget or \$28,000 yearly. Such a low fraction does not reflect the (appropriately) small student/teacher ratios which apply to grad courses in DMS and nationwide. The actual budgetary fraction devoted to the MS Mathematics program is, however, very hard to calculate, not least because it is hard to separate the teaching of graduate students from the time spent by DMS faculty doing research with graduate students, and the time spent working collaboratively with graduate students across a broad range of undergraduate teaching tasks.

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

### FTEs

The most relevant line in the PAIR data, for graduate programs, is "Faculty FTEs". Note that most DMS faculty are in 9 month positions, and thus they represent 0.75 FTE per faculty member. About 3 Faculty FTE are statistics faculty who do not teach courses with significant MS Mathematics SCH. Instructors (2 to 4 FTE depending on year) mostly are not involved in MS Mathematics teaching and advising. Also, one faculty member has a joint DMS/Education position.

With these caveats, a reasonable estimate of Faculty FTE who share responsibility for MS Mathematics program teaching and advising is  $0.75 * 10.5 = 7.9$  Faculty FTE.

2) Describe the way this program fits into the department as a whole.

What other programs are offered in the department and how are they connected with this program?

What percentage of faculty and staff time is devoted to this program as opposed to others offered?

What are the budgetary needs associated with this program in particular, e.g., how many faculty teach exclusively or predominantly the courses required for this program?

Do those courses meet requirements for other programs?

Are there any special equipment, space, commodity or other needs associated with the program that are not covered by student fees?

### Other programs in DMS, with connections to the MS Mathematics program

DMS is responsible for six different degree programs:

1. Core instruction for all Baccalaureate programs across UAF.
2. B.A. in Mathematics
3. B.S. in Mathematics
4. M.S. in Mathematics
5. M.S. in Statistics
6. Ph.D. in Mathematics.

In addition, we offer a minor in Statistics, a minor in Mathematics, and a Graduate Certificate in Statistics. Within the B.A. and B.S. degrees in Mathematics, there is an option to concentrate in Statistics.

DMS acts as an integrated whole: all permanent faculty with research responsibilities teach at all levels of the curriculum (undergraduate and graduate). The five (current) instructors teach mostly at the 100-level, plus some 200-level calculus courses. Also, one instructor both runs the Math Lab, where graduate TAs do the tutoring part of their job, and teaches the 1.0 credit MATH 600 Teaching Seminar for graduate students.

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

MS Mathematics students are the majority of TAs in the Department, with a smaller fraction from the PhD program. DMS graduate TAs are essential to the delivery of UAF's Core curriculum, helping in the instruction for MATH 113, 151, 156, 251, and 252 in particular.

### **Percentage of faculty time devoted to the MS Mathematics program**

All permanent research DMS faculty are involved in all aspects of the undergraduate and graduate programs. Faculty are not pigeon-holed into teaching particular courses as is commonly found in, say, the sciences. An instructor with a Ph.D. in Mathematics can teach all courses at the undergraduate level in MATH and across a broad choice of graduate-level MATH courses.

All permanent research DMS faculty are involved in the comprehensive exam process for MS Mathematics, and as committee members, and/or committee chairs, for MS students.

However, the **vast** majority of MATH and STAT teaching effort is dedicated to service courses at the level of MATH 253 or below ("MATH-Lower" and "MATH-Outside"). Permanent research MATH DMS faculty with a typical 60/30/10 contract will, in a typical year, teach three undergraduate courses and perhaps one graduate course.

Regarding faculty time spent supervising MS Mathematics research, note that nationwide a large fraction, nearly 100%, of "pure" mathematics research occurs at a level which does not and cannot include MS Mathematics students. Indeed, in contrast to laboratory and field sciences especially, even PhD students can rarely help their advisors in a research capacity. The relationship between faculty and MS student is strongly of mentoring, and only minimally that of teamwork, when proving mathematical theorems.

### **What are the budgetary needs of this program in particular?**

The whole DMS faculty, and its Chair, work in an integrated manner to support the MS Mathematics program. No permanent faculty member (research faculty or instructor) is exclusively devoted to the program. (There is an uncompensated Graduate Coordinator position held by a faculty member, with primary responsibility for the timing and execution of the comprehensive exam process.) As noted above, the majority of DMS teaching is at the undergraduate level, even for research faculty. Thus there is probably no reasonable way to fully separate the budgetary impact of the MS program from the other DMS MATH programs (esp. BA/BS and PhD).

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

Of faculty time spent teaching graduate courses, a significant part is “service” to other departments. For instance, applied mathematics courses routinely have half or more of their students from other majors (see below), but these courses are also important electives for MS Mathematics majors. There may be no reasonable way to separate MS Mathematics teaching and graduate service teaching in terms of budget impact.

In fact, the MS Mathematics graduate program actually enables DMS to significantly improve our Core MATH offerings for UAF undergraduates at relatively low cost overall. These TAs provide more hours of instruction, of various types, than DMS expends on them in teaching graduate courses. While a precise assessment of costs of the MS Mathematics program is difficult due to the intertwining of the many missions of DMS, it is hard to see where any budgetary savings could arise in eliminating the MS Mathematics program, should that be considered.

Support for faculty and graduate student travel has been minimal. Despite the high costs of travel to and from Alaska, we believe travel support is much less than at many of our peer institutions. This is unfortunate, since research in the mathematical sciences is often stimulated by the personal interactions that occur through professional travel.

### **Do these courses meet requirements for other programs?**

**Yes!** Of the **fifteen** 600-level MATH courses listed in the current catalog, all of which have been taught in the review period, **seven** (611, 612, 614, 615, 660, 661, 663) are used as electives by graduate students outside of DMS to satisfy advancement-to-candidacy requirements. Of these courses, at least five (esp. 611, 612, 614, 615, 660) have more than 30%, and over 50% in some courses, of non-MATH major enrollment.

Also, several 200-, 300-, and 400-level mathematics courses are used by non-MATH graduate students to resolve weak math backgrounds, or to satisfy advancement-to-candidacy requirements. Note MATH 421 can be used to satisfy the catalog requirements of the Ph.D. in Geophysics.

### **Are there any special equipment, space, commodity or other needs associated with the program that are not covered by student fees?**

Certain graduate MATH courses would serve students better if technology could be an integral part of the class experience. However, computer lab space is not available for most courses. (Historically, when the Computer Science (CS) Department split off from DMS to join CEM in 2005, they became sole owner of the previously joint MATH-STAT-CS computer lab in Chapman.) Thus there is a **pressing need for a Computer Lab** for DMS. It is hard to believe there exist other PhD-granting universities which do not support the teaching of mathematics and statistics with such a facility.

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

- 3) Does this program have sufficient resources (people, space, time, funding, student interest) to adequately meet its objectives in a sustainable manner?

DMS does not have sufficient full-time faculty to effectively offer all the courses needed for our preferred MS Mathematics curriculum, but it can minimally meet the objectives of the program with our current faculty.

Space for DMS in Chapman Hall is severely limited, and it remains unclear how this will be addressed. We use two converted seminar rooms and a temporarily-vacated office "borrowed" from CS for graduate student and adjunct office space. Other graduate students and faculty are in windowless offices with no ventilation systems. There is no private office space available for all four current instructors on a long-term basis. Space for a badly-needed computer laboratory remains elusive.

DMS has one full-time administrative assistant, one part-time staff member who serves the Math Bridge program, and one or two student office assistants. This small staff supports more than 10,000 SCH per year, as seen in the PAIR data, across all degree programs and service obligations of DMS.

- 4) Describe the productivity of the program faculty in publication, scholarship, teaching, funded research and service. Mention specific Unit Criteria if they will help the committee to assess the level of scholarly productivity. List any grant funding associated with the program faculty during the review period.

The current make-up of full-time faculty in DMS is ten mathematicians (Allman, Avdonin, Bueler (75% DMS), Berman, Faudree, Gimbel, Maxwell, Rhodes, Rybkin, Williams), one mathematics educator (Rickard 50% in DMS), four statisticians (Barry, Goddard, McIntyre, Short), plus five instructors without research responsibilities. We restrict our answer to this question to those 15 faculty members of DMS with research (tripartite) appointments.

### Research papers

Research faculty members with appointments in DMS have been extremely productive: over the 5 years of this review, a total of 122 papers have been published, along with 158 research presentations. This works out to be almost two papers published per faculty member per year. DMS research faculty is exceedingly productive, particularly when measured using the publication norms in the mathematical sciences (below).



## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

We note that the **culture of mathematics is very different** than that of the physical and natural sciences. The main professional organization of research Mathematicians in the United States, the American Mathematical Society (AMS) each year publishes a "culture statement" to make known more broadly the norms for productivity and grant funding in mathematics. According to the AMS (see culture statement 2006 on publication rates included in the appendix), the publication rate in mathematics is modest in comparison with other sciences. To highlight this point, this document examined the publication rates during five years preceding the awards of Sloan and Guggenheim Fellowships and found that 70% of the Sloan awardees and fewer than 50% of the Guggenheim awardees published more than two articles annually. The culture statement goes on to explain that in mathematics *quality* not *quantity* is the measure of productivity.

The approved DMS unit criteria reflect this cultural norm, and states that it

"expects faculty with a 30% research load to be publishing at a rate of approximately one paper per year. At a 50% level or above there should be approximately two. However, it should be emphasized that this is only an approximate goal. The more important goal is quality research."

As noted, mathematics research, especially in "pure" areas, often has no available role for MS students. However, during the review period one faculty member (Rybkin) authored 5 papers with MS students (3 are published, one accepted, and one submitted). Another (Berman) had one published paper co-authored with an MS student in the review period, while yet another (Rhodes) has a paper with an MS student co-author under review.

### External Funding

In regard to grant funding, DMS research faculty is also highly successful. We note first that grant funding in mathematics is very limited in comparison to other sciences, and that individual grants are typically of smaller value. Moreover, some sub-areas of mathematics are not funded at all by federal funding agencies. To substantiate this assertion, we quote from the 2006 "culture statement" of the AMS devoted grant funding (see appendix),

"... In 2006, across all fields of science, 46.9% of those employed in academia received Federal support for their research: 56.3% of physical scientists, 43.9% of computer scientists and 57.9% of life scientists, as compared to 34.8% of mathematicians.

As compared to other natural sciences, there is also a large disparity in the per capita level of funding available to mathematicians. In FY2006, across all fields of science and engineering, the Federal government provided about \$260,000 per academic researcher. By field, this breaks down to \$360,000 per academic researcher in Computer Science, \$140,500 per academic researcher in the Physical Sciences, and \$430,000 per academic researcher in the Life Sciences. By contrast, in 2006 the Federal government provided about \$47,000 per academic researcher in Mathematics.



## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

When compared to other fields of science and engineering, opportunities for external funding in mathematical sciences are very limited. The vast majority of mathematicians receiving Federal support have just one, single investigator, NSF grant."

The DMS Unit Criteria also reflect this reality:

"Certain disciplines found in mathematical sciences have little opportunity in the way of external funding. Accordingly, the ability to find funding speaks well for a candidate at any level. However, absence of funding may not necessarily speak against the candidate. DMS does not consider the funding of grant proposals to be the goal of any research project. Rather, we focus on what is achieved with or without research funding."

Over the review period, research faculty in DMS applied for 42 grants of various types, ranging from small travel grants of a few thousand dollars to large grants from the NSF, NASA, and NIH for hundreds of thousands of dollars. See table below for data on funded grants. Remarkably, when restricting to grants over \$100,000, we see that six faculty members (some repeatedly) were funded during the last five years. Moreover,  $6/15 \approx 40\%$  of the faculty were funded by large federally-funded research grants; compare the fact that nationally less than 35% of mathematicians are supported by federal grants.

The following table describes these grants:

<b>Allman</b>	<b>NIH</b> "Mathematical and computational analysis for species tree inference" 2015-19 (submitted and awarded during review period) with co-PI J. Rhodes (\$1,543,627)
	<b>NSF</b> "Enhancing Phylogenetic Methods and Theory via Algebraic Perspectives" 2007-2012 with co-PI J. Rhodes (\$486,450)
	<b>NSF</b> "Participant Support: 2011 Mittag-Leffler Institute" (\$48,515)
	Erskine Fellowship, University of Canterbury 2013
	NIMBioS short-term visitor grant
	AIM SQuaRE grant (2011-2013)
	NIMBioS working group grant
	GCAT Workshop on synthetic biology
	Mittag Leffler Institute Research Fellowship
	University of Tasmania Visiting Scholar
	SAMSI Research Fellow
<b>Avdonin</b>	<b>NSF</b> grant 2014--2017, "Control and Inverse Problems for Differential Equations on Graphs" (\$147,000)
	Australian Research Council grant, "Interrogation and Estimation of Differential Equation

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

	Networks" (with W. Moran and M. Morelande) 2013--2015
	<b>NSF</b> grant 2007--2011, "Boundary Inverse Problems in Glaciology" with M. Truffer and D. Maxwell (\$385,000)
<b>Barry</b>	<b>U.S. Fish and Wildlife</b> , support for a graduate student for two years. (Study of the geospatial estimator for moose populations when densities are low).
<b>Berman</b>	Simons Foundation Collaboration Grant for Mathematicians 7/1/2011 – 8/31/2016 (\$35,000)
<b>Bueler</b>	Ed Bueler (PI), Mark Fahnestock (Co-I), Andy Aschwanden (Co-I), and Constantine Khroulev (senior personnel), Understanding measured variability in the Greenland ice sheet using the Parallel Ice Sheet Model (PISM), <b>NASA</b> Modeling Analysis and Prediction, NNX13AM16G, funding period June 2013--June 2017 (\$737,000)
	Ed Bueler (PI), Regine Hock (Co-I), David Maxwell (Co-I), and Martin Truffer (Co-I), A high resolution Parallel Ice Sheet Model including fast, sliding flow: advanced development and application, <b>NASA</b> Modeling Analysis and Prediction, 2009--2013. (\$994,000)
<b>Gimbel</b>	Czech National Science Foundation Scholarship
	Charles University Research Fellowship
<b>Maxwell</b>	<b>NSF</b> FRG: Collaborative Research: Analysis of the Einstein Constraint Equations, 2013-2014, (\$150,000)
	Ed Bueler (PI), Regine Hock (Co-I), <b>David Maxwell</b> (Co-I), and Martin Truffer (Co-I), A high resolution Parallel Ice Sheet Model including fast, sliding flow: advanced development and application, <b>NASA</b> Modeling Analysis and Prediction, 2009--2013. (\$994,000)
	<b>NSF</b> grant 2007--2011, "Boundary Inverse Problems in Glaciology" S. Avdonin with M. Truffer and <b>D. Maxwell</b> (\$385,000)
<b>Rhodes</b>	<b>NIH</b> "Mathematical and computational analysis for species tree inference" 2015-19 (submitted and awarded during review period) with co-PI J. Rhodes (\$1,543,627)
	<b>NSF</b> Grant #0714830: Enhancing Phylogenetic Methods and Theory via Algebraic Perspectives, Division of Mathematical Sciences, Program in Mathematical Biology; with co-PI Elizabeth Allman 2007-12 (partially in this period, but awarded earlier) (\$486,450)
	AIM SQuaRE grant (2011-2013)
	Mittag Leffler Institute Research Fellowship and other fellowships
	NIMBioS short-term visitor grant
	Erskine Fellowship, University of Canterbury 2009
	University of Tasmania Visiting Scholar

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

<b>Rybkin</b>	<b>NSF</b> DMS-1411560, Integrable PDEs and Hankel operators, 09/01/14-08/30/17 (\$213,000)
	<b>NSF</b> REU supplement; 2015 (\$42,000)
	<b>NSF</b> DMS 1126006, REU supplement; 06/10/11-06/30/14 (\$36,126)
	<b>NSF</b> DMS 1009673, Inverse Scattering Transform and non-decaying solutions of completely integrable nonlinear PDE's, 07/01/10-06/30/14 (\$200,000)
	<b>NSF</b> DMS 0907801, REU supplement, 06/10/09-08/31/10 (\$45,000)
	<b>NSF</b> DMS 0707476, Titchmarsh-Weyl m-function and integrable nonlinear PDE's; 09/01/07-08/31/10 (\$115,000)
<b>Williams</b>	Fields Institute Travel Grant

### Teaching:

As described in detail above, DMS contributes to teaching at all levels; it provides an important part of the baccalaureate core, it provides quantitative training for engineers and other technical disciplines, and it provides quality graduate education both for its majors and in a service role for other graduate programs.

### Service:

Members of DMS contribute to service in all its forms: department, university, professional, and public service.

DMS frequently has representatives serving on college-wide and university-wide committees. During the time of review, this included Faculty Senate, Program Review, University-wide Promotion and Tenure, Curriculum Review (both college- and university-wide), General Education Revitalization, Curricular Affairs, Unit Criteria and Faculty Affairs. There are several university-wide committees that have required DMS participation, including Core Review (which was chaired by the DMS representative for several years during the period under review) and Student Academic Development and Achievement.

Members of DMS have also served on various ad-hoc committees, such as the *Educate* Subcommittee of the Strategic Planning Committee at UAF, the UAF Life Sciences Informatics Advising committee, and the system-wide General Education Learning Objectives committee.

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

After analyzing student success rates in lower-division MATH and DEVM courses, DMS initiated a Subcommittee on Math Placement which suggested using a new mechanism (the ALEKS placement test) for placing students into their MATH and DEVM (and STAT 200) courses in fall 2014. Roll-out of this new placement scheme involved faculty and staff across all areas of the university.

In addition, DMS faculty served on the Joint Health Care Committee and on the Honors Faculty Advisory committee, and one DMS faculty member served as the Chief Negotiator for the current Collective Bargaining Agreement.

DMS faculty members regularly serve as judges at local science fairs, and one person recently was the plenary speaker for the New Mexico High School State Mathematics contest.

Research faculty are also highly involved with service to the discipline. This includes service as peer reviewers for professional journals, and as editors of peer-reviewed mathematics journals.

### NEED FOR PROGRAM

- 1) UAF'S mission and Core Themes are attached. How does this program contribute to that mission and those themes? Is this program uniquely central to the mission?

Mathematical and Statistical training are central to UAF's mission and fit well into UAF's core themes. Part of the University's responsibility is to provide for adequate quantitative training of its citizens; to prepare Alaska's future workforce (e.g. mathematics teachers, scientists and engineers with advanced quantitative skills, statisticians for jobs in state positions, etc.) and to advance the boundaries of mathematical and statistical knowledge.

Any academically strong mathematics department needs to have a strong graduate program in order to fulfill the mission of a research university. Funding agencies like NSF explicitly require addressing broader impacts, and explicitly target support for research that works with students, so maintaining a graduate program with adequate UAF support is crucial to securing external funding in an extremely competitive market. Our Department is unable to offer postdoc fellowships, but it consistently supports both strong graduate research training and undergraduate research experiences (see REU below, for example).

The Mission Statement of the University of Alaska Fairbanks says that the university "... advances and disseminates knowledge through teaching, research and public service...". DMS directly contributes to this part of the Mission by providing quality teaching to a majority of students who attend the university through the required core mathematics requirement or through program requirements such as the calculus sequence.

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

Research knowledge is advanced and disseminated by publications in mathematics and statistics in peer-reviewed journals, and by contributing to the discipline and the general public in a service capacity, including as local science fair judges, statistical consultants, organizers of math contests, as well as serving on local boards.

The MS Mathematics directly contribute to all of UAF's Core Themes, namely **Educate**, **Discover**, **Connect**, **Prepare**, and **Engage**.

**Educate:** Courses used to fulfill requirements for the Math MS program are taken by students across UAF's science and engineering disciplines. Some courses (MATH 611, 612, 614, 615, 660, 661) are used to fulfill advancement-to-candidacy requirements by graduate students from other units. The MS Mathematics degree appeals to different populations of students, including those interested in mathematics research at the PhD level, a career in mathematics teaching, especially at the college level, and those interested in working in the public sector or in industry.

**Discover:** The department has researchers who are highly productive, in a variety of mathematical and statistical disciplines. Departmental researchers frequently present at national and international conferences and are involved in collaborations around the world. They also mentor students, both at graduate and undergraduate levels, to discover their own paths to mathematical research.

**Prepare:** Courses that satisfy requirements for the Mathematics MS are used to prepare graduate students in mathematics, science, and engineering. The program also contributes to preparing the mathematics teachers, and the leaders of mathematics education, of Alaska.

**Connect:** Through eLearning and the offering of MATH and STAT courses at rural campuses, DMS connects students all over Alaska with mathematics and statistics instruction and training.

**Engage:** MATH and STAT courses are taken by students of all age demographics in Alaska and in lifelong learning. As many job qualifications now require significant quantitative training (statistics, engineering), the role of DMS in offering its undergraduate courses is a boost to the economic development of Alaska.

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

- 2) List any active academic, community, or industry partnerships associated with this program, and briefly explain what the partner contributes (including but not limited to monetary and in-kind contributions).

### **Graduate training for quantitative fields at UAF**

One of the most important partnerships is with other Departments, especially in science and engineering, through the DMS role in training students in advanced quantitative skills. A significant fraction of the total CNSM and CEM graduate curriculum occurs through courses listed on the advancement-to-candidacy requirements for non-math graduate students. This partnership comes from the dual role of MS Mathematics courses as electives within the major and as service courses, typically in applied mathematics, outside the major.

### **Research Experience for Undergraduates (REU)**

For the review period, DMS research faculty member Rybkin has raised over \$100,000, mostly through NSF REU supplements, with some contributions from GI and URSA, to support REU activity of 17 undergraduate students. The students participated in 8 distinct projects on math modeling, six on nonlinear water wave phenomena important to tsunami modeling, and two on other applied math topics. This activity has resulted in 1 published research paper, 1 submitted, 1 in final stage of preparation, and 1 in preparation, 16 talks (in colloquium series, domestic and international professional meetings). Besides Rybkin, Dr. Dmitry Nicolsky of GI was actively involved in 5 projects, and Dr. Efim Pelinovsky of Institute of Applied Physics, Russia was actively involved in 2 projects.

### **Joint MATH-CS Graph Theory Research Group**

Members of DMS (Berman, Faudree, Gimbel, Williams) and the Computer Science department meet weekly to discuss research problems in graph theory. During the period under review, this collaboration has resulted in one published paper and one that is currently in review.

### **Partnerships with Biology and Wildlife**

Faculty members Rhodes and Allman collaborate with faculty in Biology & Wildlife to help increase the quantitative knowledge of students and faculty in biology. They both have Research Faculty appointments with IAB, and have served as informal and formal advisors on biology Ph.D. committees.

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

They have also developed an interdisciplinary undergraduate course MATH/BIOL 393 in synthetic biology, and a graduate course in "Theory of Phylogenetics" that attracts students and faculty in biology and fisheries in addition to those in mathematics and statistics. The last time the "Theory of Phylogenetics" course was offered, students and faculty from UAA and UAS enrolled remotely.

### Parallel Ice Sheet Model project

The Parallel Ice Sheet Model (PISM; [www.pism-docs.org](http://www.pism-docs.org)) is an open-source scientific software project based on a partnership of DMS with other parts of UAF, and of UAF with several other institutions. The principle investigator is DMS faculty Bueler, with MS Mathematics graduate Constantine Khroulev as lead programmer, MS Mathematics graduate Jed Brown as the former lead programmer, and DMS faculty member Maxwell as a former Co-I. Two MS Mathematics students, along with several non-mathematics UAF graduate students, have worked on PISM-related projects and theses since 2011.

UAF researchers account for about 85% of the software code base of this scientific and mathematical modeling project. It has active collaboration with researchers at the following institutions among many others who use PISM:

- \* Danish Meteorology Institute, Copenhagen, Denmark
- \* Max Planck Institute for Meteorology, Hamburg, Germany
- \* NASA Goddard Institute of Space Studies, USA
- \* Potsdam Institute for Climate Impact Research, Germany
- \* Victoria University, Wellington, New Zealand

Collectively, such collaborations, in the form of PISM model usage, have yielded 51 peer-reviewed publications since 2011, including 10 in the prestigious *Nature*, *Science*, and *Proceedings of the National Academy of Science* journals.

These collaborations represent a high degree of international visibility for UAF-based mathematics and geophysics faculty and students. The project also represents a strong intra-UAF partnership between DMS, the Geophysical Institute (GI), and the Arctic Region Supercomputing Center (now part of GI). Each of the four NASA grants supporting PISM, totaling \$2.4M for the 2001-2017 period, have had at least one DMS and at least one GI investigator, and each is based on high performance computing resources from ARSC/GI.



## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

- 3) Is this program duplicated within the UA system? If there is another program within the system, does this one have any important differences from the other program(s)?

Though UAA and UAS have BS/BA in mathematics, only DMS at UAF offers a MS degree in Mathematics (or a PhD). There are no alternatives for graduate-level mathematics degrees in the state of Alaska.

Only DMS offers graduate-level (600-level) service courses needed by science and engineering graduate students for completion of their studies. There are no alternatives for graduate-level training in quantitative sciences in the state of Alaska.

- 4) Describe the demand for the program by students and the prospective job market for program graduates. (For assessing the job market, you may find the following publication useful (<http://labor.alaska.gov/trends/>), particularly their annual employment forecast. The national Bureau of Labor Statistics also has potentially applicable information (<http://www.bls.gov/ooh/>). If your program tracks actual job placement of its graduates, please provide that information. However, it's recognized that not all degrees qualify recipients for specific occupations, so in some cases, you may need to address this question in broader terms, e.g., what skill set does the degree represent? What kinds of jobs are graduates obtaining?

The MS Mathematics program has a steady applicant pool which suggests a steady demand for this kind of education. Many students are from Alaska and have either the goal of finding employment within the state using these skills, or the goal of getting started on a mathematics research-level education, which necessarily must be followed by PhD-level education. Of the current 10 MS Mathematics majors, two were secondary teachers from the state of Alaska, and one more was an out-of-state teacher.

Regarding MS Mathematics graduates, they are successful at continuing on into PhD programs, both in mathematics and in other sciences, or in finding professional jobs using their MS-level background, according to their goals and abilities. This statement can be made with no qualifications.

In fact, in the review period, 10 students graduated from the program with a MS in Mathematics. Of those students, **all graduates in the review period either proceeded to more-advanced graduate education or are employed in positions which use the training and education provided by the program** (with initials):

## PROGRAM REVIEW 2015-16

DEPARTMENT: Mathematics & Statistics, CNSM

PROGRAM: Mathematics

DEGREE: MS

- five are currently enrolled in PhD programs, (V.G., M.H., V.M., W.M., J.B.)
- one is a full-time instructor in DMS, (O.B.)
- one is an adjunct instructor in DMS, (Y.Z.)
- one is teaching mathematics at an out-of-state junior college, (K.K.)
- one works as a software engineer, (L.G.)
- and one as a bioinformatics programmer. (M.L.)

Of the above 10 graduates, note that 3 remain at UAF as employees or students. In fact, here is a probably-incomplete list of **graduates of the MS Mathematics program currently employed by UAF**:

- Ron Barry, Professor, DMS
- Odile Bastille, Instructor, DMS
- Latrice Bowman, Instructor, DMS
- Tim Carlson, Assistant Professor, Bristol Bay Campus
- Joe Dart, Adjunct Instructor, DMS
- Sarah Garland, Program Director, Osher Life-Long Learning Institute
- Constantine Khroulev, Research Professional, GI
- Julie McIntyre, Associate Professor, DMS
- Dmitry Nikolsky, Research Assistant Professor, GI
- Tony Rickard (MAT Mathematics), Professor, DMS
- Kat Sorenson, Instructor, DMS
- Dana Thomas, Vice Provost and Accreditation Liaison Officer, retired, UAF
- Jane Weber, Associate Professor of Developmental Studies
- YuanYaun Zhao, Adjunct Instructor, DMS
- Beth Zirbes, Instructor DMS

It is thus no exaggeration to say that, merely to function, UAF depends on graduates of the MS Mathematics program. Concretely, meeting the demand of DMS to teach a large number of SCH at the "MATH-Lower" and "MATH-Outside" levels (about 9,000 SCH per year) has only been possible through the education and hiring of MS Mathematics graduates as instructors and adjuncts within DMS.

### MISSION FULFILLMENT

Attach the most current Student Learning Outcomes (SLOA) plan and most recent SLOA summary.

# College of Natural Sciences and Mathematics - Mathematics & Statistics

		FY11	FY12	FY13	FY14	FY15	FY14-FY15 Change	FY11-FY15 Change
<b>Student Credit Hours Delivered by Department</b>	<b>MATH - Lower</b>	4,596	5,142	5,826	6,674	6,621	-0.8%	+44.1%
	<b>MATH - Upper</b>	896	922	890	1,004	789	-21.4%	-11.9%
	<b>MATH - Prof</b>	72	128	0	0	0		-100.0%
	<b>MATH - Grad</b>	115	155	125	191	142	-25.7%	+23.5%
	<b>MATH - Outside</b>	1,627	1,985	2,145	3,127	2,976	-4.8%	+82.9%
	<b>STAT - Lower</b>	519	606	678	810	810	0.0%	+56.1%
	<b>STAT - Upper</b>	390	446	402	458	378	-17.5%	-3.1%
	<b>STAT - Grad</b>	91	89	123	149	188	+26.2%	+106.6%
	<b>STAT - Outside</b>	96	111	78	204	201	-1.5%	+109.4%

SCHs delivered by the department (including e-Learning/CDE) during the regular fall and spring terms are listed in the Lower, Upper, Grad, etc., lines. Summer Sessions, CRCD, and summer e-Learning/CDE SCHs are summed in Outside. There is no duplication of Outside SCHs in other categories on this report.

<b>Internal Teaching</b>	<b>In department</b>	608	670	664	739	616	-16.6%	+1.3%
<b>Service Teaching</b>	<b>In unit, outside department</b>	1,230	1,601	1,594	1,480	1,342	-9.3%	+9.1%
	<b>Outside unit</b>	4,994	5,375	5,080	5,481	5,206	-5.0%	+4.2%

"Internal Teaching" is defined here as the number of credit hours delivered to students who are seeking a degree from that same department. "Service Teaching" is the number of credit hours a department delivers to students who are not seeking a degree from that same department. Only departmentally produced credit hours are considered when evaluating service teaching effort.

<b>Majors</b>	<b>MS Mathematics</b>	7	9	12	12	10	-16.7%	+42.9%
---------------	-----------------------	---	---	----	----	----	--------	--------

A student seeking more than one degree, or changing major during a fiscal year, is counted more than once, except on the "unduplicated headcount" line.

<b>Majors' Average Annual SCH Load</b>	<b>MS Mathematics</b>	14.2	15.8	15.1	16.9	16.2	-3.9%	+14.3%
--	-----------------------	------	------	------	------	------	-------	--------

Based on the majors counted in Majors table.

<b>Majors by Race and Gender</b>	<b>Non-AK Native female</b>	2	3	3	3	2	-33.3%	0.0%
	<b>Non-AK Native male</b>	5	5	9	9	7	-22.2%	+40.0%
	<b>Total minorities</b>	0	1	1	0	0		

Based on the majors counted in Majors table.

<b>Degrees Awarded</b>	<b>MS Mathematics</b>	1	1	2	4	1	-75.0%	0.0%
<b>Majors/Degrees FY11-FY15</b>	<b>MS Mathematics</b>	5.6						

<b>Theoretical Tuition Revenue Generated by Department</b>	<b>Lower Division</b>	\$751,905	\$885,192	\$1,073,160	\$1,257,312	\$1,292,994	+2.8%	+72.0%
	<b>Upper Division</b>	\$218,620	\$255,816	\$258,400	\$298,248	\$245,070	-17.8%	+12.1%
	<b>Professional</b>	\$24,336	\$47,616	\$0	\$0	\$0		-100.0%
	<b>Graduate</b>	\$69,628	\$90,768	\$94,984	\$132,940	\$132,990	+0.0%	+91.0%
	<b>Total</b>	\$1,064,489	\$1,279,392	\$1,426,544	\$1,688,500	\$1,671,054	-1.0%	+57.0%

Calculated from departmental credit hour production and the published lower-division, upper-division, and graduate tuition rates.  
Out-of-state surcharges, tuition waivers, and fee-in-lieu-of-tuition adjustments are NOT applied.

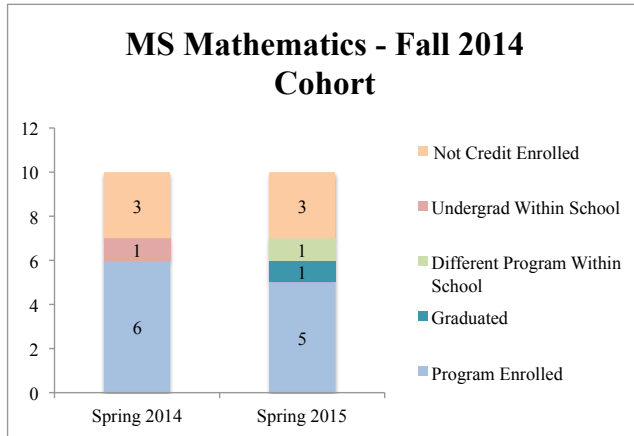
<b>Departmental FTEs</b>	<b>Adjunct FTEs</b>	2.6	2.4	1.9	4.4	4.0	-8.0%	+54.8%
	<b>Faculty FTEs</b>	10.2	11.8	10.2	11.1	12.1	+9.1%	+19.0%
	<b>Staff FTEs</b>	1.0	1.0	0.9	1.8	1.5	-17.2%	+53.2%
	<b>Student FTEs</b>	5.1	6.4	9.5	8.5	9.4	+11.0%	+85.9%

For the faculty, staff, and student job classes, this table is based on the actual number of days each employee is in active status in each fiscal year, and on the organization code(s) responsible for paying each person's salary. Note that full-time faculty on 9-month contracts will be counted as only 0.75 FTEs each. Adjunct FTE has been approximated by counting the number of course hours taught by people who have adjunct contracts with each department and dividing by 40.

## CNSM - Mathematics & Statistics, Continued

### Fall 2014 Enrollees - Look Back, Look Forward

This cohort consists of students who were enrolled for credit in the program in Fall 2014. Note that the Majors table is more inclusive, including program students who were enrolled for credit at any time during the fiscal year. Enrollment status is given for that cohort of students in the previous term (Spring 2014) and the subsequent term (Spring 2015). Only students who graduated in Fall 2014 and Spring 2015 are counted as having graduated, hence the smaller number than in the Degrees Awarded table above.



UNIVERSITY OF ALASKA FAIRBANKS  
**Student Learning Outcomes Assessment Plan**  
**Mathematics M.S. Degree**  
 College of Natural Sciences and Mathematics  
 Adopted May 2014

Expanded Statement of Institutional Purpose	Intended Objectives/Outcomes	Assessment Criteria and Procedures	Implementation (what, when, who)
<b>MISSION STATEMENT:</b>  <b>We shall provide a high quality mathematics education responsive to the needs of individual students and the diverse population of Alaska</b>	Our students will attain a level of technical ability and knowledge to prepare for thesis work and to achieve their professional goals.	Students will demonstrate their progress through course work and annual committee meetings.	The student and the student's committee will meet annually to assess student progress toward the stated objective. Progress reports will be sent to the Assessment Committee who will review them and identify concerns.
	Our students will master core mathematical concepts.	All students are required to pass four core courses and pass a collection of exams covering a subset of core areas.	Every spring, comprehensive exams will be given graded and discussed by the math faculty. A summary of the results will be prepared by the Assessment Committee.
	Communication and presentation skills are consistent with professional standards.	<b>Oral component:</b> For all students, the quality of the student's public oral thesis defense will be evaluated by a survey of department members in attendance. For students placed in the classroom, at least one permanent faculty member will observe the student each semester and write a brief description to be submitted to the Assessment Committee.	The Assessment Committee will review the results of the survey and any reports of classroom observations. Every three years, the Assessment Committee will evaluate the quality of recent theses.
		<b>Written component:</b> All students must submit a written project or thesis.	
<b>GOAL STATEMENT:</b>  <b>To assure that our graduates attain a solid understanding of mathematics and are adequately prepared to succeed in the job market or advanced study.</b>	Students will obtain employment in their chosen field, continue on to further education, or otherwise meet personal objectives for completing the degree.	Tracking of recent graduates.	Faculty will be surveyed annually regarding recent graduates. A list of graduates will be maintained.

*Submitted by: Jill Faudree*

## Annual Report for 2012

### Department of Mathematics and Statistics (DMS)

### Student Learning Outcomes Assessment (SLOA) for MS

### Degree in Mathematics

INTENDED OUTCOMES OBJECTIVES	ASSESSMENT CRITERIA	IMPLEMENTATION PROCEDURES (what, when, who)
1) Our curriculum will be comparable to national standards	Compare our program to University of Idaho, University of Wyoming, and University of North Dakota.	Every three years, the members of the Graduate Committee from mathematics will compare our program to the three specified institutions and give a report on their findings to the assessment committee to include in the annual report.

**Status:** The University of Idaho program has 17 math faculty, and appear to have 16 graduate students. The M.S. program requires students take a similar number of courses to UAF, but has comprehensive examinations on 6 topics, and does not require a project or thesis. Course offerings are slightly more extensive than UAF's.

The University of Wyoming has around 24 mathematics faculty members, and 21 graduate students (ALL of whom are supported through TA-ships!). Graduate course offerings are approximately double UAF's. The MS program is similar to UAF's, requiring both a qualifying exam and a thesis/project.

The University of North Dakota has 19 faculty, and about 10 graduate students, all with TA funding. It offers only M.S. and M.Ed. degrees, based entirely on course work, without qualifying exams or theses/projects. Although the UND catalog lists more courses than UAF offers, it appears that actual offerings are quite similar (3 or so graduate courses per semester).

UAF has only 10 full-time math faculty members to contribute to the graduate math program. Given our smaller faculty size, we have done a good job of maintaining quality programs, but we are probably a bit over-extended. Of the comparison schools, only Wyoming has courses approaching a Ph.D. level, and it has twice the staffing and many more TA-ships. We are perhaps most similar to Idaho, though with many fewer graduate students. Our program is clearly within the range of these schools', and our requirement for an M.S. project is a strength over some of their programs.

2) Our students will master a core of mathematical concepts.	All students are required to take and pass four core courses. In order to graduate, all students must take and pass a collection of exams on core subjects.	Every spring, comprehensive exams will be given, graded, and discussed by the majority of the math faculty. A summary of the results will be prepared by the members of the Graduate Committee from mathematics to be included in the yearly assessment report.
--	---	---

**Status:** During the period covered by this SLOA report (AY 2011 and AY 2012), there were 9 students enrolled in the MS program in mathematics. Of these, a total of three of these students took the comprehensive exam sequence, with two passing and one incomplete (i.e., one or more parts of the comprehensive exam sequence had to be retaken).

The four required MS-level core courses have, as stated in the UAF academic catalog, been taught one-per-semester in recent years, including the AY 2011 and AY 2012. Two additional graduate elective courses are generally offered each semester so that completing the MS in mathematics program in a two-year time frame is reasonable.

3) Our students will have the opportunity to develop the skills necessary to achieve their career goals in mathematics.	alumni survey	Every May, alumni surveys will be sent to all students who graduated with a degree in mathematics two years prior. The returned surveys will be summarized by the assessment committee in the annual report the following spring.
---	---------------	---

**Status:** No alumni surveys have been returned during the period of this SLOA report (i.e., AY 2011 and AY 2012). However, of the four MS graduates during the period covered by this report, one is employed by UAF, one is pursuing a PhD in mathematics, another is pursuing a PhD in a related field, and the fourth student's status is not known.



# Student Learning Outcomes Assessment

## Summary—Mathematics MS

Department of Mathematics and Statistics

Fall 2012 – Spring 2014

The following summary assessment of the MS, MAT, and PhD in Mathematics covers the time period from Fall 2012–Spring 2014, and was developed in conjunction with the SLOA Plan for M.S., M.A.T., and Ph.D. dated February 20, 2010.

During the time covered in this assessment, three students graduated with an M.S. in Mathematics (one in August 2012, one in May 2013, and one in August 2013), and three more are expected to finish in Spring 2014.

For Fall 2012, 10 students applied to the MS; of these, 5 were admitted and 3 attended. One of these students left after the first year, one is graduating in Spring 2014, and one is expected to finish by December 2014.

In Fall 2013, 11 students applied to the MS in Math. Of these, 8 were admitted, 5 attended, and one postponed after acceptance.

Two additional students applied in Spring 2014; one withdrew the application after admittance and one was not admitted.

### Outcome 1

From the SLOA Plan:

Intended outcomes	Assessment criteria and procedures	Implementation
Our curriculum will meet national standards	Comparison of UAF program to University of Idaho, University of Wyoming, and University of North Dakota	Every three years, the Graduate Mathematics Committee will compare our program to the three specified institutions and report their findings in its annual assessment report.

## Structure of the MS program

University	Number of credits	exams	required core courses
UAF	30 credits minimum; all four core courses	three 1.5 hour written exams covering 3 subjects and at least two core courses	Algebra I, Real Analysis, Complex Analysis, Topology
Idaho	30 credits; at least 18 credits (6 courses) in mathematics at the 500 level	4.5-hour written examination covering six courses, 5 at graduate level	at least six 500-level courses in mathematics
Wyoming	30 hours of formal course work at the 5000 level or above; 6 core courses	Exam in multivariate calculus and linear algebra at the level of upper-division undergraduate courses.	Core courses: Real Variables I, Complex Variables I, Methods of Applied Mathematics I, Computational Methods I, Advanced Linear Algebra, Graduate Abstract Algebra
North Dakota	30 (thesis) or 32 (non-thesis) credits; Two full graduate sequences of the five available	no exam	Core sequences: Analysis; Applied Mathematics; Algebra; Topology; Probability and Statistics

## Departmental Demographics

University	number of FT faculty	number of students	PhD?
UAF	10 TT, 2 lecturers (excluding statistics)	10 graduate students	yes
Idaho	14 TT faculty, plus an associate dean and 2 research associate professors; one instructor; one director of math lab	11 MS students and 5 PhD students	yes
Wyoming	25 TT, 7 lecturers	27 graduate students and 3 post-docs	yes
North Dakota	18 TT faculty, 8 lecturers (3 PT)	10 graduate TAs	no

Our MS is in line with those offered by the comparator institutions. Our comprehensive exams are harder than Wyoming and North Dakota, but similar in aggregate to Idaho. We have fewer choices in the required core courses, but we also don't require as many core courses to be taken; we require 4, while Idaho and Wyoming require 6. Everyone requires 30 credits and graduate courses are 3 credits.

We have fewer faculty than any of the comparator institutions and a similar number of masters students as Idaho and North Dakota; it is not apparent how many of Wyoming's 27 graduate students are masters students.

## Outcome 2

Intended outcomes	Assessment criteria and procedures	Implementation
Our students will master core mathematical concepts	All students are required to pass four core courses and pass a collection of exams (which depend on degree areas) in core areas	Every spring, comprehensive exams will be given, graded, and discussed by the math faculty. A summary of the results will be prepared by the Graduate Committee and included in its annual assessment report.

Graduate core courses in Real Analysis, Complex Analysis, Algebra and Topology were all offered on the usual schedule.

MS comprehensive exams were given in June 2011, May 2012, May 2013, October 2013, and March 2014.

In June 2011, two students took exams for the first time; topics offered were Algebra, Topology, Numerical Linear Algebra, Complex Analysis and Mathematical Physics. One student passed all three exams, and one student passed two of the three; that student retook and passed one exam in May 2013.

In May 2012, one student took and passed the comprehensive exams; topics offered were Real Analysis, Complex Analysis, and Optimization.

In May 2013, four students took comprehensive exams; topics offered were Topology, Algebra, Graph theory, Numerical PDEs, Complex Analysis, and Numerical Linear Algebra. Two students passed all three exams, one student passed two of the three and retook and passed the third in October 2013. The final student failed all three exams in May 2013; the student retook and passed all three exams in March 2014.

## Outcome 3

Intended outcomes	Assessment criteria and procedures	Implementation
Our students will have opportunities to develop the skills necessary to achieve their career goals in mathematics	alumni survey	Every three years, alumni surveys will be sent to all students who earned a graduate degree in mathematics 2, 3 or 4 years prior. The Graduate Committee will summarize responses in its annual report.

No alumni surveys were available.

Of the three students who graduated during the time of this report, one is working on a Ph.D. in mathematics at UW-Madison, one will be adjuncting for DMS in the fall, and one is pursuing a Ph.D. in geophysics at UAF.