Forest Biometrics Research Institute (FBRI) Doctoral Fellowship at the University of Idaho

The purpose of the Forest Biometrics Research Institute (FBRI) Doctoral Fellowship is to facilitate the education of forestry professionals toward an advanced understanding and application of forest biometric principals and methods. Fellows are expected to become proficient in nonparametric statistical methods as related to forestry and forest management technologies. FBRI supports and provides the Forest Projection & Planning System (FPS), an industry standard for managing forest ownerships. In addition to providing financial assistance, FBRI is offering access to a large database of field research installations and felled-tree measurements encompassing six western States and over two dozen tree species.

The FBRI Fellowship objective is to provide financial support to graduate students to pursue graduate studies without associated teaching or research responsibilities (as an assistantship). This Fellowship is an external award from FBRI to support a PhD student in a full-time course of study. The FBRI Fellowship is a three-year commitment to the selected student. The student is expected to complete all coursework and a dissertation leading to a PhD in the three-year time frame. The candidate must hold a Bachelor of Science degree in Forest Management from an SAF-accredited forestry program and be operationally familiar with the silviculture and tree species of the western United States.

The selected FBRI Fellow will join a larger cohort of Masters and Doctoral graduate students pursing advanced knowledge in the fields of Forest Biometrics and Silviculture. FBRI Students will be located in graduate student space within the College of Natural Resources. The FBRI Fellow's doctoral committee will include one Ph.D. Biometrician from the Forest Biometrics Research Institute. The student's doctoral committee has the responsibility to approve the courses and credits it considers essential for the education and development of the candidate. The committee's objective is to ensure that the student is properly trained and prepared to conduct doctoral-quality research in forest biometrics upon completion of this PhD degree.

Prior to each semester the student is responsible to consult with the committee advisor to ensure that a graduate academic plan has been developed and is being followed. The graduate academic plan must be initially approved by the student's doctoral committee. The FBRI Fellowship doctoral student must provide a progress report each year in November at the FBRI Annual Meeting (travel expenses provided by FBRI). All FBRI Fellowship doctoral students are required to participate in at least a one-month internship with FBRI or with an FBRI-affiliated forestry organization prior to completion of coursework. The internship will be tailored to match the student-selected doctoral dissertation topic.

This FBRI PhD graduate program is also open to participants not receiving a FBRI Fellowship. The program accepts interested individuals seeking Masters or Doctoral degrees with independent funding. The program also welcomes interested individuals seeking to attain a graduate degree while remaining employed in the forest industry or other land management

organizations. Successful applicants to the FBRI program with independent funding are only required to pay Idaho resident tuition and fees (detailed on following pages).

FBRI Fellowship Funds Available: $20,486 research assistant stipend and coverage of resident fees* and student medical insurance for 3 years. The College of Natural Resources will provide each FBRI Fellow with $3,000 per year to cover research costs such as computer, field equipment, and travel.

* The University of Idaho waives non-resident fees for all students participating in the FBRI Fellowship program.

Application Requirements: Applicants must be proficient in English; participate easily in team environments; and, be well-grounded in regional silvicultural systems.

Please apply to the University of Idaho's College of Graduate Studies (COGS) via the standard application process. Within your letter of application, please specifically highlight why you are interesting becoming a FBRI Fellow. Also on the CNR Area of Emphasis Form please write "**FBRI Fellowship**" where it asks you to highlight a CNR Faculty member with whom you have corresponded.

Applications Due/Start Date: The FBRI Fellowship ideally begins with the start of the Fall Semester, 2017. The student is expected to select a dissertation research topic within the scope of the FBRI field of applied technologies (nonparametric methods, quantitative aspects of tree site capacity, tree form, or tree growth dynamics. Additional details are found on a following page).

More Information (link)
www.forestbiometrics.org provides background on the Forest Biometrics Research Institute (FBRI) mission, activities and supporting organizations. FBRI's corporate office is at the World Forestry Center in Portland, Oregon. FBRI's flagship software is the Forest Projection and Planning System (FPS) which is a fully integrated inventory, GIS, silviculture, growth and planning package used by over 80 forest management organizations throughout the western United States. All quantitative parameters of tree site, volume and growth dynamics of forest trees and stands are detailed in the FPS Universal Library maintained and provided by FBRI.

These FPS parameters were derived using nonparametric regression and statistical methods using one of the most extensive research databases in forestry. Students accepted into the FBRI PhD program will have access to all of these resources.

Applicants must demonstrate a strong interest in forest biometric methods and nonparametric statistical approaches. The graduate selection committee is made up of both University and

FBRI professionals. A wide range of specific quantitative interests are welcomed as suggested in the "*FBRI Graduate Research Program – Topics*" detailed on a following page.

FBRI is looking for students willing to commit at least five years of active professional forestry participation in the Northwest following successful graduation from the FBRI program.

How to Apply (link)
https://www.uidaho.edu/admissions/graduate/graduate-programs/natural-resources

Interested persons may also contact the Forest Biometrics Research Institute directly at:

Forest Biometrics Research Institute
Attn: FBRI Fellowship Program
4033 SW Canyon Road
Portland, Oregon 97221
(503) 227-0622
Info@forestbiometrics.org

The information for this fellowship would be placed alongside the College's other fellowships and will be broadly advertised through professional outlets.
http://www.uidaho.edu/cnr/students/graduate-students/cnr-fellowships

Proposed Annual Budget per FBRI Fellow

FBRI Contribution	**1st Year**	**2nd Year**	**3rd Year**
Student Stipend ($19.70/hr, 20 hrs/wk, 52 wks/yr)	$20,486	$20,896	$21,314
Fringe (2%)	410	418	427
Resident Tuition and Fees (2017 rates*)	8,530	8,871	9,226
1 credit summer	474	474	474
Student Health Insurance Program (2017 rates*)	1,812	1,848	1,885
University of Idaho – Faculty & Admin (FBRI limit of 0%)	0	0	0
Total FBRI Contribution	**31,712**	**32,507**	**33,326**
University of Idaho Contribution			
Waiver of non-resident tuition and fees (2017 rates*)	14,808	15,400	16,016
College of Natural Resources FBRI fellowship research allowance	3,000	3,000	3,000
Total University of Idaho Contribution	**17,808**	**18,400**	**19,016**

* Resident tuition and fees anticipated to increase about 4% per year. Student stipend, fringe and health projected to increase about 2% per year.

Proposed 27 credits for PhD in Forest Biometrics

A grade of B or greater required in all courses

Core (18 credits):

- Stat 416 Statistical Analysis for Research (3 credits)
  Concepts and methods in quantitative research including observational and experimental study design, point estimation, hypothesis testing, effect size, sample size, causation, one and two-way ANOVA, simple linear regression, interpreting and reporting results.
- Stat 431 Statistical Analysis (3 credits)
  Concepts and methods of statistical research including multiple regression, contingency tables and chi-square, experimental design, analysis of variance, multiple comparisons, and analysis of covariance.
- Stat 514 Nonparametric Statistics (3 credits)
  Conceptual development of nonparametric methods including one, two, and k-sample tests for location and scale, randomized complete blocks, rank correlation, and runs test. Permutation methods, nonparametric bootstrap methods, density estimation, curve smoothing, robust and rank-based methods for the general linear model, and comparison. Comparison to parametric methods.
- FOR 529 Forest Ecosystem Analysis (3 credits) Fall Only
  Forest ecosystem processes and analysis from the leaf to the landscape scale; techniques for measuring forest ecosystem attributes; integration with forest management.
- FOR 547 Woody Plants Physiology (3 credits)
  Examine woody plants interactions with their environment and tolerance or avoidance of stress. This course covers quantitative analysis of environmental biophysics, gas exchange, water relations and nutrition in woody plants.

- FOR 570 Advanced Remote Sensing Measurement Methods (3 credits)
  Development of remote sensing methods to measure vegetation attributes from individual trees, to stands, to regional scales. Includes, LIDAR and hyperspectral data, non-traditional accuracy assessment, land-use/land-cover change assessment, linear and non-linear mixture models, autocorrelation, time series analysis, and application of object-orientated approaches. (Spring, alternate years)
- FOR 598 Internship (credits to be determined)
  Students gain experience in nonparametric consultation and / or nonparametric data analysis in their present place of employment or an arranged internship organization. Students are jointly accountable to a faculty advisor and a person providing oversight of the individual's efforts within the organization. All internship experiences must be pre-approved.

Electives (9 credits):

- CS 360 Database Systems (3 credits)
  Study of database design and implementation; comparison of basic models (entity-relationship, hierarchical, network, relational); study of query languages; discussion of issues of integrity, security, dependencies, and normal forms.
- For 424 Silviculture Principles and Practices (4 credits)
  Theory underlying silvicultural practices to control forest composition and growth, including forest stand dynamics, tree growth and quality, and growth-density relationships. Study of intermediate stand treatments and reproduction methods. Final project required involving field data collection and forest modeling to develop and mark silvicultural prescriptions. 3-hrs of lecture and 2-hrs of lab per week.
- Stat 422 Sample Survey Methods (3 credits)
  Introduction to survey sampling designs and inference including simple, stratified, and cluster sampling; ratio and regression estimators, unequal probability sampling, and population size estimation.
- Soil 446 Soil Fertility (1-3 credits, max 3)
  Principles of soil fertility management; availability of plant nutrients and their relationship to plant growth and fertilization practices.
- Math 451 Probability Theory (3 credits)
  Same as Stat 451. Random variables, expectation, special distributions (normal, binomial, exponential, etc.), moment generating functions, law of large numbers, central limit theorem. (Fall only)
- Stat 507 Experimental Design (3 credits)
  Methods of constructing and analyzing designs for experimental investigations; analysis of designs with unequal subclass numbers; concepts of blocking randomization and replication; confounding in factorial experiments; incomplete block designs; response surface methodology.
- Stat 516 Applied Regression Modelling (3 credits)
  Statistical modeling and analysis of scientific date using regression model including linear, nonlinear, and generalized linear regression models. Topics also include analysis of survival data, censored and truncated response variables, categorical response variables, and mixed models. Emphasis is on application of these methods through the analysis of real data sets with statistical packages.
- Stat 519 Multivariate Analysis (3 credits)
  The multivariate normal, Hotelling's T2, multivariate general linear model, discriminant analysis, covariance matrix tests, canonical correlation, and principle component analysis.
- Stat 538 Stochastic Models (3 credits)
  Markov chains, stochastic processes, and other stochastic models; applications.
- BUS 513 Leadership and Organizational Behavior (3 credits)

Micro oriented treatment of areas including communication, motivation, group process, conflict, leadership style.

- Stat 550 Regression (3 cr)

  Theory and application of regression models including linear, nonlinear, and generalized linear models. Topics include model specification, point and interval estimators, exact and asymptotic sampling distributions, tests of general linear hypotheses, prediction, influence, multi-collinearity, assessment of model fit, and model selection.

- AgEc 586 Regional Economic Development Theory (3 credits) Spring Only

  Theory course in the explanation and causes of regional economic growth and community development. Topics include land economics, transportation models, central place theory, location theory, agglomeration, economic base theory, and economic growth theory.

- For 572 Spatial and Biophysical Modeling (3 credits)

  Development of concepts, techniques, and methods for the fusion of remote sensing, GIS and biogeochemical modeling techniques for analyzing energy and material pathways and cycles; review latest methods for temporal and spatial scaling of datasets and models to develop and test hypotheses for understanding forest ecosystem structure and function.

FBRI Graduate Research Program – Potential Topics

Understand, explore and evaluate basic principles:

I. Growth model architecture – strengths & weaknesses (Monro, 1974)[1]
   A. Whole Stand Models – DFSIM
   B. Individual-Tree, Distance-Independent Models – FVS, ORGANON
   C. Individual-Tree, Distance-Dependent Models – FPS

II. Nonparametric statistical methods – sampling & regression
   A. Balanced orthogonal sampling designs
   B. Weighted Y-estimates at equal intervals of X
   C. Pascal smoothing techniques and assumptions

III. Only calibrate Growth Models on trees with both Dbh & Height
   A. Understanding lag effects of past density
   B. Exploring the effects of Shade Tolerance ranking
   C. Ranking and Quantifying growth dynamics by Order of Impact

IV. Understand and Calibrate 10-meter flexible site curves
   A. Differences between macro-site and micro-site
   B. Relationships of soil, climate and growing season days
   C. Moisture balance between incoming and stored precipitation

V. Silvicultural Growth Dynamics from establishment (CASH Card)

VI. Understanding Clumpiness and Spatial parameters in Inventory for Growth
   A. Tree-based Density versus Stand-based Density Measures
      i. Stand Density Index, Curtis Relative Density, Crown Competition Factor
      ii. Competitive Stress Index
   B. Stem-mapped Research plot designs versus Traditional designs
      i. Nelder plot designs
      ii. Fixed-area plots
      iii. Prism variable plot designs
   C. Experimental Unit – Tree versus Stand
      i. Calibration of Growth Models

VII. Design and Calibration of Tree Taper Class System
   A. Trends in Stem Form – Larson (1963)[2]
   B. Relationships between live crown, shade tolerance and taper class
   C. Nonparametric fitting of taper profiles

VIII. Understanding and Applying Growth Steps in Height, not Age
   A. Field precision – signal versus noise relationships

IX. External Species Parameter Libraries with Certification
   A. Development, Application, Calibration, Verification

[1] Monro, Don. 1974. Forest growth models: A prognosis. In: Growth Models for Tree and Stand Simulation. Royal College, Stockholm, Sweden. Forest Research Note 30. Proceedings of 1973 IUFRO Meetings in Vancouver, B.C.
[2] Larson, Philip R. 1963. Stem form development of forest trees. Forest Science Monograph, Number 5. 42 pages.

Background leading to forming FBRI – "The National Research Council Report"

In 1999 the National Research Council formed a Committee on "National Capacity in Forestry Research". The Committee's report was completed in 2002 and approved by the National Academy of Sciences for publication and distribution. The following statements have been quoted from that report[3]:

> "In the past decade, the forestry sector and the research capacity in that sector have seen substantial changes… Our national capacity in forestry research appears to have waned even as the demands placed on our forests and the need for enhanced technical knowledge has increased. We must have better information on the status of forestry research and future research priorities if we are to identify critical research needs and we need to identify the types of scientists and disciplines required to produce knowledge about our nation's forests."
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> "In brief, this report suggests that our current forestry research capacity is neither adequate now, nor poised for success in the coming years. This report identifies significant declines in real research capacity, fragmented cooperation and poor communication among the principal providers and users of forestry research, inadequate support of both foundation and emerging disciplines, and little strategic planning to address future forestry research needs."
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> "In the committee's opinion forestry research capacity is at a crossroads, if not a precipice."
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> "The forestry research sector is indeed at a crossroads. If left unchanged, its future will entail a steady erosion of intellectual and institutional capacity, and dwindling capacity and impact. Alternatively, forestry research could renew its commitment to innovation, cooperation, relevance, and extension in order to prosper and enhance the practice of forestry in this century. This latter vision will require levels of cooperation, support, real exchange of financial and technical support, and stakeholder support that do not currently exist."

The Forest Biometrics Research Institute (FBRI) was formed precisely to fulfill this need documented by the National Research Council report. The formation of FBRI was initiated by Dr. James D. Arney in 2002.

Trends in Operational Forest Management

[3] The report is available from the National Academy Press in Washington, D.C. as International Standard Book Number 0-309-08456-3 and contains 144 pages.

Most private forestry companies have long ago down-sized their technical support departments in favor of a leaner organization. The USFS Experiment Stations have all but curtailed further development in biometrics tools to assist forest managers. This is especially true in the development and support for forest management software. The result is that high quality, robust forest management and planning software is difficult, if not impossible, to find. Learning how to develop Environmental Impact Statements (EIS), Sustained Yield Plans (SYP) or Habitat Conservation Plan (HCP) documents is beyond many landowners. This scarcity of forestry software and methods has become the single most limiting constraint to development of sound forest management programs within the private forestry sector.

Forest management and long-range planning has evolved since the 1980s from general guidelines in an annual report to location-specific treatment regimes overlaid on a geographic information system at the beginning of each year. This rush to specificity is the result of a trend in State-mandated forestry regulations. These regulations are becoming increasingly detailed and complex in all western States with the objective to protect riparian zones around streams, wildlife habitat and wildlife travel corridors.

Private and public land owners are finding that every acre has its own set of constraints. These depend on the current development of the existing vegetation, the type of soil, topographical stability, proximity to roads and to streams, constraints on the watershed basin within which it resides and on the matrix of other owners that may make up the entire basin of interest.

Many public land management agencies and private forest companies have developed EIS, SYP and HCP documents to provide written commitments to stated levels of forest stewardship. The difficulty is that the methods are undefined, constraints un-quantified and databases incomplete. As a result, each land manager is expending a significant portion of time and energy in *developing* methods, constraints and databases to be used as a basis for planning. However, the time and energy was anticipated to have been expended on *evaluating* silvicultural alternatives and the impacts of these alternatives. As a result, time runs out and the land manager is left with less than expected results and many times, with less than the best forest management range of options. Decision-making occurs with less than adequate information.

The FBRI Mission, Products and Services

The Forest Biometrics Research Institute (FBRI) received IRS 501(c)(3) tax-exempt status beginning on August 14, 2003. The mission of FBRI is:

a) Organized for advanced research, education, and service in the field of forest biometrics;

b) Devoted to the advancement of scientifically grounded and verified forest biometrics practices and procedures in the forest industry; and,

c) Structured to serve the forestry profession.

The Forest Biometrics Research Institute (FBRI) attempts to provide a robust suite of decision-support tools and methods for forest management and planning. FBRI continually strives to provide accurate assessments of growth and yield for all forest types and silvicultural approaches. No other organization has taken on this mission in service, education and research. FBRI approaches are highly dependent on robust biometric methods and skill-sets.

Therefore, FBRI has launched an aggressive program into graduate forestry research to ensure an ongoing high level of service to the forestry profession for decades to come.

James D. Arney has a Ph.D. in Forest Biometrics. He has over fifty years of experience in research, development and implementation of forest inventory, forest growth projection and forest planning technologies. Dr. Arney owns a forestry consulting business, Forest Biometrics, LLC.