General note: This draft version of the course syllabus is subject to change. Revisions will be posted to the FLBS website as they are received. The final syllabus will be marked final and will be distributed on day one of the course.

Prerequisites: Basic coursework in GIS is mandatory (can be met with FORS 250 Introduction to GIS for Forest Management or GPHY 284 Introduction to GIS and Cartography). Knowledge of or course work in remote sensing is preferred, but not required.

Course Description:
This course will introduce students to field-based methods of close range remote sensing in freshwater ecosystems. Students will gain knowledge of basic spatial analysis through GIS and remote sensing techniques. Students will learn basic application of drones and ADP, two remote sensing instruments of fast growing interest in ecological research and application. Students will learn about essentials to operate drones and ADPs, initial post processing of data products and integrating these data into ecological research and application.

Ecological systems are diverse and spatially heterogeneous areas characterized by interacting natural and impacted terrestrial and aquatic mosaics, which consist of features, such as forests, grasslands, rivers or lakes. Key research topics in these landscape mosaics include the analyses, quantification and scaling of ecological flows, land-use and land-cover change, relating landscape pattern analysis with ecological processes, conservation and sustainability. In this context GIS analyses in concert with close range remote sensing using unmanned aerial or aquatic vehicles (UAVs), autonomously or remotely operated and equipped with various sensors such as NIR (Near infrared), TIR (Thermal infrared) or ADP (Acoustic Doppler Profiler) offer new opportunities for scale appropriate measures of ecological phenomena at high spatial-temporal resolutions.

Student Learning Objectives:
After completing this course students will be able to:

GIS/RS and Technology
- Describe basic drone protocols for collecting data (flight planning, air space classifications, height restrictions, weather patterns, permits, etc.)
- Collect, process, control, clean up, and import Drone and Acoustic Doppler Profiler (ADP) data into ArcGIS.
- Classify drone imagery in ArcGIS, discerning water from other habitat and land use categories.
- Integrate ADP and drone imagery in ArcGIS for aquatic and terrestrial spatial analyses (Habitat diversity, depth, velocity, and temperature distributions).
Ecological

- Describe how close range remote sensing can be used to assess, quantify, and monitor landscape and habitat properties and changes in freshwater environments.
- Link remotely assessed data to ecological relevant data, e.g., habitat properties, vegetation distribution, potential species distribution.
- Integrate collection, processing, and analysis of RS and ecological data for freshwater research and application into a proposal/report
- Critically evaluate and interpret remote sensing data for ecological research and application (quality control, data calibration, limits of application)

Required Text: None.

Reference Texts: (1) Carbonneau, P.E. and H. Piegay. 2012. Fluvial Remote Sensing for Science and Management. Wiley-Blackwell. (2) van der Meer, F.D. and S.M. de Jong. 2001: Imaging spectrometry – Basic principles and prospective applications. Springer. Note: Students who already own these texts are encouraged to bring them; however, it is not necessary to purchase the texts for the course. Electronic copies of reference readings and excerpts will be provided by the instructors.

Course and Field Supplies/Equipment (*available for purchase at the FLBS Bookstore)

- Waterproof field notebook (Rite in the Rain No. 393 spiral notebook)*
- Pencils or All Weather Clicker Pen*
- Hot/cold mug*
- Plastic, resealable containers for lunch pack-up*
- Laptop
- Proper clothing, rain gear
- No camping gear for this course
- Water bottle*
- Wading shoes
- Bear spray (optional)*
- Sunglasses, sunscreen, cap/hat
- Daypack
- First aid kit (personal size)
- Insect repellent

- Other items to bring checklists: http://flbs.umt.edu/urls/lists

Evaluation and Grading:

<table>
<thead>
<tr>
<th>Grading</th>
<th>A</th>
<th>A-</th>
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<tbody>
<tr>
<td></td>
<td>≥94%</td>
<td>90–93%</td>
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<tr>
<td>B+</td>
<td>87–89%</td>
<td>B</td>
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<tr>
<td>B-</td>
<td>80–83%</td>
<td>C+</td>
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<tr>
<td>C</td>
<td>74–76%</td>
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Quizzes 25%
Research proposal written report 30%
Research proposal presentation 45%

Quizzes
Quizzes will be both written and computer examples. Quizzes on basic concepts of GIS and remote sensing, drone/ ADP use and operation, and computer exercises using GIS and remote sensing techniques will be completed during the first week of the course.

Research Proposal – Written Report and Presentation
As students progress in their academic and professional career, they will find the need to write proposals to guide their research, solicit funding, and meet reporting requirements. During the first week of class, students will review research integrating remote sensing and freshwater ecosystems. By the end of week 1, students
will write group proposals, incorporating baseline field data you that they will collect during the course. The last day of the class the students will present a power point or prezi presentation describing their group project for colleagues from class and at FLBS. In addition, graduate students will have to submit a written report with their project clearly showing the linkage between science and technology. Graduate students will need to demonstrate their ability to integrate the role of technology used into a broader ecological context and to discuss opportunities and limits of application in science and practice.

**Course Policies:**
Students will adhere to University of Montana Student Conduct Code and Discrimination, Harassment, Sexual Misconduct, Stalking, and Retaliation Policy, which may be accessed at this link: http://www.umt.edu/safety/policies and to the Biological Station Code of Conduct re: form signed to complete student registration.

Students who have not already completed the University of Montana PETSA training may access the Moodle module at this link: http://www.umt.edu/petsa.

Students must also follow FLBS Rules and Regulations and abide by the Safety Orientation Checklist.

**Schedule:** The schedule below is subject to change. It based on the 2017 syllabus updated with 2018 dates.

Note: Make sure you pack your brown bag lunch each day at breakfast!

<table>
<thead>
<tr>
<th>Date</th>
<th>Lectures/Exercise/Field Work</th>
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<tbody>
<tr>
<td>6-Aug-18 (M)</td>
<td><em>Lecture and discussion</em> - General introduction and goals of the course. Introduction to GIS/ Remote Sensing and stream ecology.</td>
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<td><em>Exercises</em> - Hands on examples and exercises, data processing, classification and information extraction using ArcGIS</td>
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<tr>
<td>7-Aug-18 (T)</td>
<td><em>Lecture and discussion</em> - Introduction to Drone and ADP systems, Quiz # 1</td>
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<td><em>Fieldtrip</em> – Potential trip to Whitefish (consulting firm) in afternoon or demonstrations on and near FLBS grounds.</td>
</tr>
<tr>
<td>8-Aug-18 (W)</td>
<td><em>Lecture and discussion</em> - Case study examples, Quiz # 2</td>
</tr>
<tr>
<td>9-Aug-18 (Th)</td>
<td><em>Fieldtrip</em> – Nyack floodplain in the morning – evaluate potential field collection sites.</td>
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<td><em>Exercises</em> – Start exploration and discussion of student group projects. Hypotheses, design, and data needs.</td>
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<tr>
<td>10-Aug-18 (F)</td>
<td><em>Exercises</em> - Revision and finalization of group projects proposals. Groups present research proposals.</td>
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<td><em>Fieldtrip</em> – Potential trip to Whitefish if it did not occur on Tuesday in the afternoon.</td>
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<tr>
<td>13-Aug-18 (M)</td>
<td><em>Fieldtrip</em> - Nyack for data collection.</td>
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<tr>
<td>14-Aug-18 (T)</td>
<td><em>Fieldtrip</em> - Nyack for data collection.</td>
</tr>
<tr>
<td>16-Aug-18 (Th)</td>
<td><em>Exercises</em> - Final analysis and interpretation of data for group projects. Preparation of presentation and report.</td>
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</table>
17-Aug-18 (F) | Group Presentations and discussions in the morning. Wrap up, feedback on goals achieved. Discussion of overall class content and improvements.

Students with disabilities may request reasonable modifications by emailing flbs@flbs.umt.edu or contacting Marie Kohler at 406-982-3301 ext. 221. The University of Montana assures equal access to instruction for students with disabilities in collaboration with instructors and Disability Services for Students. The University does not permit fundamental alterations of academic standards or retroactive modifications.