PMI Periodical

Director's Corner | Spring 2023
Dave Wagner - Associate Director

Hi Everyone,

Greetings from snowy Flagstaff! With more than 5 feet of snow just in January, it has been quite the winter here in Flagstaff. But regardless of the weather, the great scientific work continues here at PMI. In this issue of the newsletter, we are very excited to bring you information about a great program, headed up by Greg Caporaso at PMI and his colleague Joslynn Lee at Ft. Lewis College, that is engaging Native American students in hands-on computer work, including developing open-source software. This innovative project, which established the Four Corners Science and Computing Club (4CSCC), seeks to provide Native American students with training that will make access to STEM careers more achievable.

We've also included our latest group photo, which includes well over 100 people. You may notice that Paul Keim is missing from that photo, as he is enjoying a sabbatical at Oxford University this academic year. That said he is still (of course) actively engaged in many of our research projects from afar. PMI has been steadily growing over the years and we continue to train many undergraduate students and send them out into the workforce, or on to graduate and professional schools. Our undergrads are the backbone of PMI and we're always sad to see them go, and we've listed our graduating seniors in this edition.

We've also included some fun old photos, photos of the newest members of the PMI family, and several other items.

Enjoy,
Dave Wagner

NAU | NORTHERN ARIZONA UNIVERSITY

In the Spotlight

PMI Newborn

Arabella Jane Phillips

Weight | 7lbs, 4oz

Length | 19 inches

Parents | Paul & Carina Phillips

Birth Date | December 29th, 2022

PMI Newborn

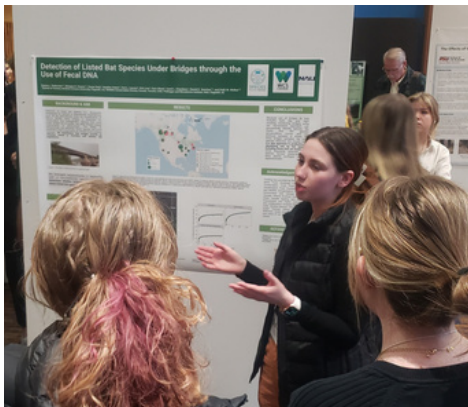Soren M. Caissie

Weight | 5lbs, 6oz

Length | 17.3 inches

Parents | Janelle Runberg & Aidan Caissie

Birth Date | November 3rd, 2022

First Place Winner for The Wildlife Society Arizona/New Mexico Conference

Emma Federman's Presentation on "Detection of Listed Bat Species Under Bridges Through the Use of Fecal DNA"

Blast From the Past | 2011

Nathan Stone's Presentation on "Cattle Fever Ticks Collected from TX Deer and Cattle Share a Common Gene Pool" 2nd Place at 7th Annual College of Engineering, Forestry, & Natural Sciences Undergraduate Research & Design Symposium (UGRADS)
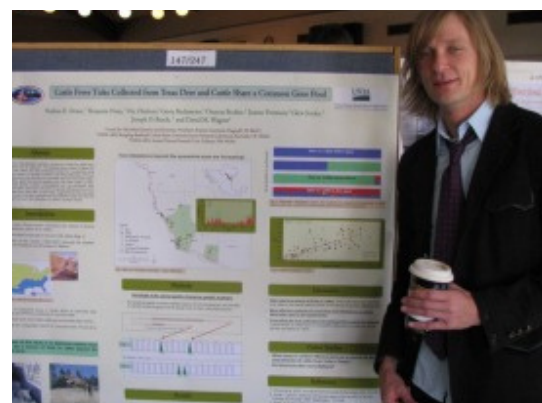
The walker Lab
Daniel Sanchez, Anna Riley, Kiera Majzner, Emma Froehlich, Faith Walker, Ellen Liebig, Emma Federman (Not pictured: Meagan Owens)
Photo courtesy of K. Ng.


Deployed passive air filters.
Photo courtesy of C. Chambers.

Air Sampling for Vertebrates |
Faith Walker and Lab Team

The field of environmental DNA (eDNA) continues to move into new and exciting territories using creative methodologies, and my team has been delighted to be part of these efforts. While eDNA as a biomonitoring tool in aquatic systems is routine, it is challenging to acquire eDNA in terrestrial systems. Last year we discovered that we are able to detect terrestrial vertebrate DNA using active air filters (Garrett et al. 2022, Environmental DNA, DOI: 10.1002/edn3.385). In two projects, we are now determining whether we can use passive air filters to detect bat species at roosts and on the landscape. Should this become a reliable method, using air filtering to capture DNA will be revolutionary to biomonitoring.

PMI Undergraduate Leadership Team |
Matthew Morales

The PMI Undergraduate Leadership Team is currently made up of Matthew Morales (Head Undergraduate), Holly Hansen (Trash/Recycling Coordinator), and five small group leaders: Jessica Marshall, Emma Federman, George Testo, Meagan Owens, and Daisy Barroso. We strive to create a learning and inclusive environment, so the undergraduate research program can continue to jumpstart careers. In addition to the research we contribute to our faculty group, our goals are focused around ensuring that PMI lab space is fully functional, well stocked, organized, and neat. As undergraduate leaders, we share our knowledge with others by training fellow undergraduates. We set high expectations for academics, professionalism, and research.
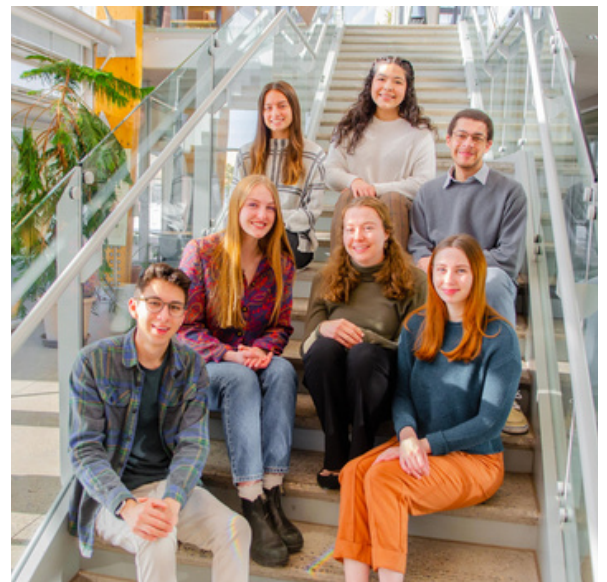
PMI Undergraduate Leadership Team
Matthew Morales, Jessica Marshall, Holly Hansen, Daisy Barroso, Meagan Owens, George Testo, Emma Federman
Photo courtesy of K. Ng.

Engaging Native American Students in Open Source Software Development

Greg Caparoso & Joslynn Lee | Chan Zuckerberg Initiative Science Blog | January 31st, 2023

The Four Corners Science and Computing Club (4CSCC) is building towards increasing the representation and inclusion of Native American students in the open source scientific community, bringing culturally relevant hands-on computer science training to Native American students to make the pathways to STEM careers more accessible.

Mentoring in Native American communities is a core cultural practice in which the entire community contributes to raising and teaching children. Implementing a culturally responsive learning environment for Native American students in the classroom starts with mentoring and relationship-building between students, teachers, and among students themselves. We believe that intentional partnership and mentorship can have a massive reach and impact on students' lives and their families and communities, which is why we're building toward increasing the representation and inclusion of Native Americans in open source scientific computing.

4CSCC aims to develop engaging hands- on activities that integrate computing and scientific methodology in projects that are directly relevant to students' lives. Building connections with Native American students while encouraging their exploration of STEM results in a more positive attitude towards computing and interest in it as a future career path. Our team has connections with schools in tribal communities throughout the U.S. and is developing collaborations with other teams and organizations with related goals.

Greg Caparoso and others
Photo courtesy of NAU Marketing.

By traveling to schools, conferences, and hosting workshops on campus, we have observed firsthand their excitement for STEM. These are comments from middle and high school students who attend a primarily Navajo-serving school after a November 2022 workshop hosted at Northern Arizona University (NAU):
"I liked [putting] a computer together and learning about the computer."
"What I liked about this session was building a computer with my friends."
"I liked the presentation and putting the computer together by ourselves."

In a typical workshop, we begin with a brief introduction to the event and instructor team and a discussion of the importance of computation to modern and future science. Physical computing and robotics are effective approaches that excite young people about computing. Therefore, our workshops involve students assembling a Raspberry Pi 400 in a custom kit designed by the 4CSCC team that includes various types of hardware and software. We later have students wire a single-color LED and write a program to flash the LED using Scratch 3, a visual programming language designed for teaching programming and with libraries supporting hardware integration on the Raspberry Pi platform.

Our workshops are typically led by teams of science professors, undergraduate, and graduate students, some of whom are Native American, who assist with hands- on activities and building kits. We always start with one of our Native American instructors giving a short introduction focused on their career pathway and how computers enable their science. They will share aspects of their identity to help students get to know relatable role models who they can connect with culturally. We've found this is key to building trust and sparking curiosity, which ultimately inspires some of the students to follow a path toward computing in science.

Photo courtesy of NAU Marketing.

Next, we typically have students connect sensors to their computers, including temperature, air pressure, humidity, volatile organic compounds (VOC), and particulate matter (PM), for data collection exercises focused on air quality. Students load a dashboard built for this purpose by the 4CSCC team on their Raspberry Pi computers. During longer events, we guide students through experimental design and execution, focused on what may or may not impact the air quality measured by the different sensors.

We conclude the workshop with a second Native American instructor sharing their journey to computer science, as well as a quick discussion of career opportunities in STEM and opportunities for financial assistance for prospective Native American college students. For example, both Northern Arizona University and Fort Lewis College provide free tuition to Native Americans.

In our workshops, we ask the students for ideas on how they might be able to use computing to improve their lives, their homes, or their communities. We hope to ultimately bring students' ideas to fruition in new computing lab exercises and even in real-world applications of computing. For example, a student pitched an idea of using float levels and lights to indicate when livestock water tanks are empty or near empty in a way that could be visualized when driving by on an adjacent road. This would reduce the time needed to monitor these tanks for ranching families while also alerting them to problems

(e.g., if a tank is empty earlier than expected, that can save livestock lives by alerting the family to the problem). By encouraging students to develop the project ideas, we hope to ensure that the content will be interesting, relevant, and motivating to future students and seed even more exciting ideas.

One of our key challenges is that schools we hope to connect with have varying ranges of available resources, from schools with fully equipped computer labs, fast and reliable internet connections, and science classrooms with attached greenhouses to schools with outdated computer hardware and limited Internet bandwidth. Students' computer access at home is also highly variable.

To address these challenges, we have developed our own portable equipment to bring to schools to standardize the experience and therefore, our curriculum and preparation. In previous workshops, we have also shipped computer kits and cellular Wi-Fi hotspots to students who attended remotely. It ultimately may make sense for us to develop a mobile computing lab that we can bring to schools to provide a consistent and exciting experience for students while minimizing setup time and bespoke curriculum development for schools based on their available resources. This could be a trailer or school bus outfitted with desks, computing, and science lab supplies.

So far we have held seven half-day workshops at Navajo Nation schools and Northern Arizona University. We're proud that these events have served students ranging from middle school through college. And separately, we hosted a college hackathon at the American Indian Science and Engineering Society (AISES) National Conference in October 2022. We have also held two "train-the-trainer" sessions at NAU, where our lead instruction

team trains additional individuals to co-teach and ultimately lead their own 4CSCC events at their own institutions. Ultimately, we hope former 4CSCC learners eventually become trainers and leaders, navigating the new generation to their own future that meaningfully increases the representation of Native Americans in open source scientific computing.

The kit students use to put the computer together includes a Raspberry Pi 400 (which is a Raspberry Pi 4 built into a keyboard), a mouse, a 7-inch monitor, a SparkFun Qwiic pHat Extension, which provides easy access to the Raspberry Pi's signature 40-pin GPIO array, and a collection of data sensors and single and multi-color LEDs, which vary in the complexity of their connection to the Pi.
Photo courtesy of NAU Marketing.

Students working on their kits at the workshop.
Photo courtesy of NAU Marketing.

FOOTNOTE: *How we use the term Native American: There is no standard descriptor for identifying those who call themselves American Indian, American Indian and Alaska Native (AIAN), Indigenous, or Native. The terms are used interchangeably and are based on preference of the communities and individuals themselves. Indigenous peoples have individual preferences on how they would like to be addressed. We are aware of the variation among the 500+ tribal nations in the United States and respect the differences in their traditions, cultures, languages, and worldviews.

Greg Caporaso is a Professor of Biology and Computer Science at Northern Arizona University in Flagstaff, Arizona, USA. With formal training in both biochemistry and computer science, he got involved with bioinformatics software engineering early in his career. His most widely known project is QIIME 2, which is the most broadly used platform for microbiome data science. Greg is most excited about making powerful scientific computing tools accessible to users with diverse backgrounds, which he believes can increase the pace of scientific progress toward solving global problems.

Joslynn Lee is enrolled Pueblo of Laguna (K'awaika) and is also of Pueblo of Acoma (Haaku) and Navajo (Diné) tribal affiliation. She is an Assistant Professor of Chemistry at Fort Lewis College in Durango, CO, USA. Prior to her current appointment at FLC, she was a Data Science Educator at Cold Spring Harbor Laboratory's DNA Learning Center and Science Education Fellow at Howard Hughes Medical Institute. Her experience in the areas of computational chemistry/biology encouraged her to develop research opportunities in microbiome research and genomics in a culturally appropriate manner..

This article was originally published as Engaging Native American Students in Open Source Software Development on the Chan Zuckerberg Initiative Science blog (https://czi.co/3Dt4xon) on January 31, 2023.

Graduating Seniors for Spring 2023

Note About the Seniors | Dawn Birdsell

This May 2023, we will graduate a large cohort of seniors, 15 students, which comprise 37% of our entire actively enrolled student body in the Undergrad program. Among these are our Head Undergrad (Matthew Morales), Small Group Leaders (Meagan Owens and Daisy Barroso), and our Trash and Recycling Coordinator (Holly Hansen). It will be a challenge to replace the caliber and contributions of these soon-to-be graduates, but they can continue to their next adventures with pride for the positive legacy they leave behind at PMI. We are grateful for their research contributions, training of the newer enrolled students, and leadership (in a formal and informal capacity). We look forward to formally acknowledging their accomplishments during our PMI Senior Recognition Ceremony held on May 12th. Prior to this ceremony, if you see any of these soon to be graduates, please encourage them as they prepare for their next professional adventure and thank them for their contributions to making PMI a highly-productive, positive, world-class research institute. We wish our soon-to-be graduates well as they prepare to embark on their next great adventure.
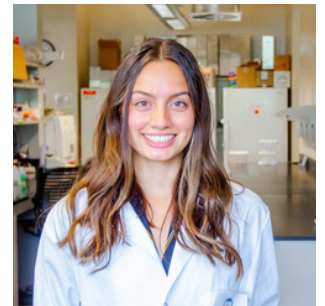
Hannah Brosius
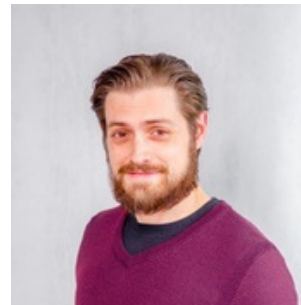
Reanna Bourgeois

Daisy Barroso

Holly Hansen

Paige Hawkinson

Emily Kissel

Derek Lake

Matthew Morales

Isaiah Raspet

Meagan Owens

Johnathan Ray

Anna Raygoza

Laney Roberts

Kyle Simmons

George Testo

Grant Pemberton

Distinguished Senior Award |
Derek Lake

  Thank you for offering me the opportunity to write about my recognition as the College of the Environment, Forestry, and Natural Sciences Distinguished Senior of the Year. Receiving this award is an honor that reflects the hard work, dedication, and passion for academic and extracurricular pursuits within the College of Environment, Forestry, and Natural Sciences. My mentor, Jason Sahl, has been integral to my development as a scientist and bioinformatician, which positioned me for receipt of this award. He mentored me in bioinformatic data analysis and introduced me to the use of long-read sequencing and other cutting-edge genomic technologies. Jason has also helped fine-tune my presentation and communication skills, which gave me the confidence to apply for graduate programs in Genetic Counseling and several awards, including the CEFNS Distinguished Senior Award.

  The journey to receiving this award was not without challenges. While serving as a Research Assistant, I initially faced setbacks while trying to incorporate wet lab and bioinformatics skills simultaneously. However, with Dr. Sahl, Chandler Roe, and Kristen Kyger's guidance, I was able to assist in complex projects at the intersection of genomics and bioinformatics while incorporating emerging technologies, such as long-read sequencing and novel bioinformatic algorithms, into my work. Receiving the Hooper Undergraduate Research Award was a significant turning point in my academic journey. This award acted as a crucial test of my ability to manage complex projects and troubleshoot through difficult challenges. It prepared me for the CEFNS Distinguished Senior Award selection process, recognizing the achievements the Sahl Lab assisted me in achieving. It also has helped prepare me for graduate school and my current life's goal, co-founding a Precision Genomic Medicine Clinic focused on expanding accessibility of genomic medicine. This award serves as a recognition of the steps I have taken toward that goal. Thank you for the opportunity to share my experiences and insights with your readers!

Derek Lake
Photo courtesy of K. Ng.

Undergraduate Research Program

Dawn Birdsell | February 16st, 2023

As the Associate Director of the Training and Education Core for the Pathogen and Microbiome Institute (PMI), I oversee the undergraduate research program. Undergraduate students are the next generation workforce, and the PMI undergraduate research program is designed to instill timeless professional skills that will enable students to successfully manage challenges in their future professions. This is the mission of NAU, PMI, and our funding agencies. The key to students' professional transformation is learning through active experience. Our program helps prepare students for real-world challenges with hands-on experience in research.

Currently, 36 actively enrolled student researchers work around 15 - 20 hours a week all year round. With 15 different research groups, students have opportunities to study topics across a wide range of different disciplines. Included are viruses, bacteria, and fungi that cause deadly diseases like Zika, melioidosis, and Valley Fever. PMI is also involved in research of microbes related to environmental conservation efforts, and the development of software to help researchers manage complex databases or investigate connections between the microbiome in the guts of mammals and diseases like Alzheimer's, for example. In the internationally recognized cutting-edge PMI labs, students learn alongside some of the world's leading microbiologists and genomics experts who identify superbugs through DNA sequencing, track pathogens to study deadly outbreaks, and develop vaccines to prevent disease.

Dawn Birdsell and Student
Photo courtesy of K. Ng.

But getting into the program takes persistence and a committed mindset. A student must first apply, and our application process is not easy. We ask questions, conduct interviews, and perform reference checks. We want students who will stick it out because we invest so much in those whom we hire. As a result, the work that goes into finding serious applicants appears to pay off. The PMI undergraduate research program has a high retention rate (> 85%). This reflects the positive relationships that are fostered through clear communication, structured training, proficiency tests, evaluations, feedback, and opportunities to improve.

Newly hired students undergo extensive training and continuous education. They are assigned multiple research projects (individual and team) and attend lab meetings. In addition, students attend a mandatory professional development workshop conducted every two weeks. These workshops include panel discussions on business skills like resume development, interviewing tips, and grant writing. This workshop series also includes invited guest speakers who talk about their professions and the journey that got them there. I often ask these speakers to come with nuggets of wisdom to pass along to students.

One such speaker was a medical doctor who works at the Centers for Disease Control in Fort Collins, Colorado. The doctor is part of the epidemiology team in charge of tracking the Zika virus and has traveled extensively to South America where the mosquito-transmitted epidemic emerged. She gave her top ten things you can do, even if you have zero talent, including, "Have a strong work ethic and have some enthusiasm. If it doesn't interest you, either leave or figure out how to make it interesting". I continually assess the students' professional development needs through surveys and informal conversations. Developing students' communication skills (verbal and written) is built into the research program design by requiring students to present their research in weekly lab meetings and conferences.

In addition, students are encouraged to apply for many competitive scholarship opportunities that require communication of their research. As a result, many of our students (some years as many as 50% - 60%) are awarded scholarships, grants, and prizes that reflect their skillful ability to effectively communicate their work.

The undergrad program is unique and transformative. I started working at PMI in 2006, after working in labs at other universities. I have never seen a program like this one. It has a structure in place that provides an opportunity for students to achieve more than they thought was possible. Students come to the program as passive learners, and they leave as teachers and leaders. It's a community within a science ecosystem. Not only do the students experience peer support for lab challenges, but that support crosses over into their academics. Students are always coaching each other and helping one another.

Most of our undergrad students are more than ready to take on a graduate's program once they graduate due to the training rigor of our program. If students can keep the commitment and do the work, then they will be transformed professionally. In addition to numerous professional skills gained, students graduate with letters of recommendations, resume building experiences, professional connections, and most are co-authors on manuscripts.

Professional transformation of students into competent skillful professionals is the mission of NAU, PMI, and our funding agencies. Evidenced by the continual professional success of our past students and numerous awards of our current students, I am confident that our undergrad research program is highly effective in accomplishing this mission.

PMI Undergraduates
Photo courtesy of K. Ng.

PMI Undergraduates
Photo courtesy of K. Ng.

PMI Lab
Photo courtesy of K. Ng.

PMI Lab
Photo courtesy of K. Ng.

PMI Undergraduates
Photo courtesy of K. Ng.

PMI Undergraduates
Photo courtesy of K. Ng.

The Pathogen and Microbiome Institute | Then VS. Now

Do you recognize some of the faces that have been at PMI for the past 15 years?

PMI All Hands | 2007

The Pathogen and Microbiome Institute has grown tremendously in the past decade and a half. PMI now occupies two floors in the Applied Research and Development Building. We have doubled the number of Undergraduate Students and currently have approximately 47 Undergraduate Students, bringing the total number of PMI employees to a whopping 142 total. PMI's Research Undergraduate Students perform vital tasks supporting the Institute's efforts in world-class leading-edge pathogen genetic research. They are mentored by staff and faculty and are paid competitive wages for their work. They are included as co-authors on all scientific publications to which their research contributions contributes.

PMI All Hands | 2022
Photo courtesy of K. Ng.

PMI Admin Team

Deborah Martin

PMI Admin Team
Makenzie Miller, Deborah Martin, Gloria Cody-Begaye, DeAna Torres,
Sharon Loy, Anna Raygoza, Laney Roberts
Photo courtesy of K. Ng

Hi PMI Family,

As you may know, the admin team for PMI supports all research teams at PMI in placing orders, assisting with travel, receiving packages, onboarding and offboarding employees, to name but a few. The PMI admin team undergrads are foundational to the support of the outstanding research done at PMI, and vital to the mission of the PMI admin team. It is with mixed feelings that I write this article. The PMI Admin Team is changing soon. Two members of the PMI admin team; Anna Raygoza and Laney Roberts are graduating May 13, 2023. Anna and Laney are, and have been vital members of the PMI Admin Team. During Covid, and a staff vacancy in PMI, Anna joined the PMI admin team in August of 2020. Laney was hired the following summer, August 2021. Both received awards from the NAU office of Student Financial Aid for their work here at PMI. First, Anna received the NAU Award for the top student employee on campus for 2022. This is the first time a PMI student employee has received this honor. Anna's exemplary role of leadership, and her initiative set her apart, and made her the natural NAU Student Employee of the Year for 2022. To top that further, Anna and Laney were awarded Honorable Mention as the NAU student team of the year. Their work supporting the PMI research community has been second to none. I am saddened to see them go, and their leaving is bittersweet. They will be greatly missed! I pray for the very best in their futures and look forward to hearing of the wonderful things they are doing.

The PMI admin team has two new members: Makenzie Miller and DeAna Torres. Please join me in welcoming these outstanding students to the PMI Admin Team. Included are photos of Anna and Laney, as well as the entire PMI admin team for your viewing pleasure.

Debbie

Laney Roberts, Anna Raygoza, Makenzie Miller,
DeAna Torres
Photo courtesy of K. Ng

Laney Roberts and Anna Raygoza
Photo courtesy of K. Ng

PMI Periodical

Please Keep In Touch!

We love hearing from all of our alumni and friends! If you have news to share, please take a moment to complete the following to update us with your latest news, accomplishments and contact information.

NAME _____

ADDRESS _____

_____

CITY _____ STATE _____ ZIP_____

PHONE _____

EMAIL _____

Alumni Only: Year Graduated _____

Degree _____

Current Occupation and Employer _____

What's new in your career, research, family? _____

_____

Return your information to:
Northern Arizona University
The Pathogen and Microbiome Institute
PO Box 4073
Flagstaff, AZ, 86011
Or email the information to
pmi@nau.edu
For donations to our research, send check or money order to:
NAU Foundation
PMI Fund # 4993 **or**
Keim Undergraduate Research Excellence Award Fund # 1882
The Pathogen and Microbiome Institute
PO Box 4094
Flagstaff, AZ, 86011

NOTE: your information will be used for internal database purposes only and will never be shared with anyone outside the administrative office, without your expressed consent.