**Western Michigan University**

**Cover Sheet**

**Faculty Research and Creative Activities Award**

**FY 2009-2010**

<table>
<thead>
<tr>
<th>1. Name</th>
<th>PI: Dr. Robert L. Anemone, Assoc. Professor, Anthropology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Co-PI: Dr. Jay Emerson, Associate Professor, Geography</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>3. Rank</th>
<th>__ Professor ___</th>
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<tbody>
<tr>
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<td>XX Associate Professor ___ Instructor</td>
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<tr>
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<th>5. College</th>
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</table>

<table>
<thead>
<tr>
<th>6. Campus phone</th>
<th>7-4133</th>
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<tbody>
<tr>
<td>e-mail address</td>
<td><a href="mailto:anemone@wmich.edu">anemone@wmich.edu</a></td>
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<table>
<thead>
<tr>
<th>7. Title of project (Limit to 63 characters, including spaces.)</th>
</tr>
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<tbody>
<tr>
<td>Using GIS and Remote Sensing in the Search for Fossil Mammals</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8. Abstract of project (including objectives and significance). Limit to the space below.</th>
</tr>
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<tbody>
<tr>
<td>Recent advances in the fields of Geographic Information Systems (GIS) and Remote Sensing (RS) can greatly increase the likelihood of locating productive fossil-bearing localities. This project aims to develop a predictive model for the presence of mammalian fossils based on an analysis of geological and geospatial data using techniques from GIS and RS. Combining detailed geological data collected in the field with remote sensing data available through the LANDSAT program in a GIS database (using ArcGIS software), we will identify the characteristics of productive fossil localities and distinguish them from other locations that lack fossil remains. These data will then be used to create an artificial neural network model to identify other localities that have a high potential for bearing fossils. This proposal will support the geological, paleontological, and GIS fieldwork in Eocene (ca. 50 million year old) deposits of the Great Divide Basin of southwestern Wyoming required to develop and field-test this predictive model.</td>
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<th>9. FRACAA applicants can apply for awards up to $10,000.</th>
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<tr>
<th>10. Type of Research Methodology (must check one)</th>
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<tr>
<td>X Quantitative Sciences ___ Qualitative Scholarly ___ Creative Arts</td>
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<th>11. Is this project currently supported by other sources, including departmental resources?</th>
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<td>RECEIVED DEC 02 2009 RSP</td>
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12. Human subjects, animal use, radioactive materials, and/or biosafety information

This project does not involve human subjects.
This project does not involve animal use.
This project does not involve radioactive materials.
This project does not involve recombinant DNA biosafety hazardous materials.

If human subjects, animals, radioactive materials, or recombinant DNA biosafety hazardous materials are involved, compliance with University policy is required. The project director(s) should contact Research and Sponsored Programs at 7-8270 for procedures and information regarding the Human Subjects Institutional Review Board (HSIRB), Institutional Animal Care and Use Committee (IACUC), the Radiation Safety Committee (RSC), and the Recombinant DNA Biosafety Committee (RDBC).

13. Signatures and Certification

(a) If the proposed activity involves the use of human subjects, human materials, vertebrate animals, radiation safety, or recombinant DNA hazardous materials, I understand it will be necessary to obtain appropriate review and approval prior to initiating the project.

(b) I certify that the statements herein are true and complete to the best of my knowledge and accept, if funds are awarded, the obligation to comply with the Faculty Research and Creative Activities Award terms and conditions in effect at the time of the award.

Project Director (Signature required. Please sign the original in blue ink.) 12/1/09

14. I support the project, including making available the facilities and existing departmental equipment necessary for conduct of the project. Also, I understand that the funds for re-assigned time can be applied only if the faculty member is officially scheduled to teach.

This project does √ does not require special facilities.
This project does √ does not use re-assigned time/buy-out time.

Chair (Signature required. Please sign the original in blue ink.) 12/1/09
Dean (Signature required. Please sign the original in blue ink.) 12/2/09

15. Use the following checklist to ensure a complete application:

√ Cover Sheet (both sides)
√ Eligibility Form
√ Proposal Narrative (7 pages or less)
√ Budget Worksheet/Detailed Justification (Amount Requested __________)
√ Attachments (e.g., bibliography, references, and vitae)

√ Submit one original of the following: Signed cover sheet, eligibility form, proposal narrative, budget/worksheet detailed justification, and attachments (e.g., bibliography, references, and vitae).

√ Submit 8 copies of only the following: Narrative, budget worksheet/detailed justification, and bibliography.

Rev. 2/09/2009 All previous forms are obsolete and should not be used.
ELIGIBILITY FORM

Faculty Research and Creative Activities Award
FY 2009-2010

This form establishes the eligibility of applicants for access to the Faculty Research and Creative Activities Award (FRACAA). It must be submitted with your completed proposal. Individuals eligible for awards are restricted to all those holding Board-appointed faculty rank who are members of the bargaining unit at the time that the FRACAA proposals are due; who were not funded by FRACAA during the preceding two academic years; and who submitted a satisfactory final report for their most recent FRACAA award. If for some reason there is a question regarding your eligibility, you will be notified.

Applications must be received no later than 4:30 p.m. on Friday, December 4, 2009, in the Office of Research and Sponsored Programs (240W Walwood Hall, 2305 Friedmann Hall, or 242-C Parkview Campus). For off-campus applicants, a December 4, 2009, postmark will be accepted. You may submit only one FRACAA proposal per year.

Name Robert L. Anemone  Campus phone 387-4133

Department Anthropology College Arts and Sciences

1. Have you received Faculty Research and Creative Activities Award or (previous named) FRACASF Award monies in the past? What year(s) 2006, 2007, 2008

   What was the outcome of the award(s)? (external grant, book, publications). 3 published papers in peer-reviewed journals, 8 presentations at national meetings

2. Have you applied for non-University grant support for a project related to your latest FRACAA award? If the application was not submitted through Research and Sponsored Programs, attach documentation.

3. Does your appointment at WMU terminate during the FRACAA program year (July 1, 2010-June 30, 2011)

   Yes ☑ No ☐

Revised – 02/09/09 All previous forms are obsolete and should not be used.
Using GIS and Remote Sensing in the Search for Fossil Mammals

FRACAA Proposal
December 2009

PI: Robert L. Anemone
Department of Anthropology
Co-PI: Jay Emerson
Department of Geography

Recent advances in the fields of Geographic Information Systems (GIS) and Remote Sensing (RS) can greatly increase the likelihood of locating productive fossil-bearing localities. This project aims to develop a predictive model for the presence of mammalian fossils based on an analysis of geological and geospatial data using techniques from GIS and RS. Combining detailed geological data collected in the field with remote sensing data available through the LANDSAT program in a GIS database (using ArcGIS software), we will identify the characteristics of productive fossil localities and distinguish them from other locations that lack fossil remains. These data will then be used to create an artificial neural network (ANN) model to identify other localities that have a high potential for bearing fossils. This proposal will support the PI’s geological and paleontological fieldwork in Eocene (ca. 50 million year old) deposits of the Great Divide Basin of southwestern Wyoming, and will allow the predictive model to be fully developed and field-tested. Successful development of this predictive model would have significant impact on the paleontological search for fossils anywhere and at any time period in Earth history.
Introduction and Background

The search for vertebrate fossils has always involved some combination of scholarly intuition, scientific data, field experience, and frankly, luck. The scientific data involved in identifying a location to search for fossils traditionally includes geological knowledge of the availability of sedimentary deposits of the correct age that are exposed and accessible for surface collecting or excavation. Having identified the presence of suitable sedimentary deposits (that may extend over a huge and often inaccessible area), the paleontologist must then rely on intuition, experience, and serendipity in choosing where to concentrate his or her team’s fossil prospecting and collecting efforts (Asfaw et al. 1990). Experience suggests that fossils are not distributed randomly or equally within exposed sedimentary deposits, a viewpoint strengthened by the occasional existence of extremely rich, but very rare bone beds or death assemblages (Gunnell 2001). The recent discovery of an extraordinarily rich fossil mammal locality in Eocene rocks of the Great Divide Basin by my field crew during the summer of 2009 reinforces for me in a very personal way the important role that chance can play in the success or failure of a paleontological field project. It also suggests the significance of seeking ways in which the odds of success can be stacked in the favor of the paleontologist searching for vertebrate fossils.

Beginning in 1994, I have taken field crews of students and colleagues to the Great Divide Basin of southwestern Wyoming nearly every summer for a month of geological and paleontological fieldwork (Anemone and Dirks, 2009). Prior to our 2009 field season, we had identified approximately 75 fossil-bearing localities and had recovered and identified slightly more than 7000 mammalian fossils from the Paleocene and Eocene epochs, between 55 and 50 million years ago. Since the Great Divide Basin was mostly unexplored by paleontologists prior to our work, our results have been recognized by our colleagues as a significant contribution to the study of the Paleocene and Eocene mammals of Wyoming. However, the state of preservation and completeness of our fossils has always been somewhat disappointing, and the richness of our sites was moderate at best when compared to some of the better-known fossiliferous deposits of the American West (Johnson, 2005). This state of affairs changed radically during July 2009, when our crew located one of the richest Eocene fossil mammal localities in the entire Rocky Mountain region. Our preliminary lab work on the fossils collected
from our new Locality 222 indicates that we recovered more than 4000 mammalian jaws, teeth
and limb bones representing 20 different taxa from this site during a single week of surface
collecting and dry-screening of the sandstone deposits there. The extraordinary richness of this
site can be understood by the simple fact that in one week there, we recovered more than half of
the total number of fossils that we had recovered in 12 prior month-long field seasons. Finding
this locality has made us think long and hard about the factors that influence the location of
fossils in the field, and how we might identify the “signature” of sedimentary deposits that have
a high potential for bearing rich fossil deposits.

The goal of this project is to develop and field-test a predictive model for the presence or
absence of fossils based on geological and geospatial data derived from investigations in the
field and the analysis of remote sensing data. We propose to apply new tools and techniques
from the geographic sciences (including global positioning systems or GPS, geographic
information systems or GIS, and remote sensing or RS) to the problem of identifying and
prioritizing sedimentary deposits with respect to their probability of containing fossil deposits of
interest.

While developed on fossil-bearing deposits from the early Eocene of the American West,
this methodology will be modifiable and adaptable for use in other geological and
palaeontological contexts. In particular, the development of this model will contribute to
improving the scientific basis for determining where to search for fossil humans in Africa. The
development and application of the predictive model to the study of human origins will benefit
the field of Anthropology by decreasing the long-term costs of human paleontology research and
by increasing the probability of success in the search for human ancestors.

The recovery of fossil primates (both non-human and human) remains one of
Anthropology’s highest priorities because fossils are the non-renewable, fundamental, data of
human evolutionary studies. Unfortunately fossils are not always easy to come by, and are often
distributed sporadically over extensive badland areas: “Decades of research at major
palaeoanthropological sites in eastern Africa ... have shown that the archaeological and
palaeontological resources they contain are effectively non-renewable (emphasis added) given
geomorphological and geographical constraints” (White 2004: 341). Archaeological and
palaeontological material lost due to this problem makes it highly desirable for
palaeoanthropologists to utilize new and emerging technologies enabling them to explore large
geographical areas in more efficient and predictable ways. An excellent example of such methods is found in the work of the Paleoanthropological Inventory of Ethiopia inaugurated by B. Asfaw and colleagues (Asfaw et al. 1990). In this, and subsequent work, remote sensing techniques were used to highlight ground cover changes, presence of volcanic deposits useful for dating, fault structures, and exposures of particular sedimentary deposits known to contain fossils. Armed with these remote sensing data, field workers could specifically target promising paleontological and archeological areas in a highly effective and efficient way. Such studies led directly to major hominid discoveries in the Kesem-Kabena and Fejej regions of Ethiopia and represent some of the most successful uses of Remote Sensing in paleoanthropology (Fleagle et al. 1991; Wood 1992; WoldeGabriel et al. 1992; Haile-Selassie et al. 2007).

Although it has been used by Denver Museum of Natural History crews in long term studies of the vertebrate paleontology of the Wind River Basin in Wyoming as an aid to “identifying basic geological units and facies, and areas of exposure in unexplored regions” (Stucky et al. 1989: 35; Stucky et al. 1987), remote sensing continues to be an underutilized technology by North American vertebrate paleontologists. Matthews and colleagues discuss the application of remote sensing and photogrammetry (i.e., measurements derived from photos or remote sensing imagery) to fossil resource management (Matthews et al. 2006). GIS applications in vertebrate paleontology are substantially more numerous than is the case for remote sensing. A simple predictive model of fossil abundance has been developed by Oheim (2007) using GIS and suitability analysis based on elevation, rock unit, vegetation cover, and distance to roads in the Cretaceous Two Medicine Formation of Montana. Stigall and Lieberman (2006) reviewed the ways in which GIS can be used to analyze patterns in fossil distributional data and implications for analysis of biogeographical patterns in the past and conservation biology today.

This research project seeks to build upon and expand the technical armamentarium of paleoanthropologists by developing predictive search models using data derived from both Remote Sensing and GIS. While GIS has already had an enormous impact in archaeology (Wheatley and Gillings 2002) and has found some use in mapping hominid deposits in South Africa (Nigro et al. 2003), its full potential has yet to be utilized in paleoanthropology. The numerous ways GIS could be employed by paleoanthropologists were recently discussed by myself and colleagues from Washington University (Conroy 2006; Conroy et al. 2008). By
using the powerful spatial analysis tools of GIS, we can create numerous map layers characterizing the landscape of potential surface prospecting areas (e.g., degree and direction of slope, elevation, geological maps, access roads, drainage patterns). These different map layers can all be interrogated, combined, and "intersected" to create new map layers that delimit just those *combinations* of characteristics that we would predict should be fossiliferous (and accessible). This has never before been done in paleoanthropology, and the extensive Eocene deposits in the Great Divide Basin provide a unique opportunity to create and field test such a GIS predictive model.

**Detailed Methodology**

The data required to develop and to field test the predictive model proposed here are of three different types: geological data, geospatial data, and remote sensing data.

1. **Geological data**, including detailed descriptions of rock types, lithologies and facies of rock units of interest will be collected in the field. Geological interpretations of environments of deposition and other structural features will also be worked out, both in the field and back in our labs after fieldwork is completed. We will collect this geological data from a representative sample of different lithologies, including both productive localities and areas that have proven to be barren with respect to mammalian fossils. The goal is to characterize the geological setting of both kinds of deposits in order to include geological variables in the predictive model. Some examples of the kind of geological data we will use in the predictive model include the following: mineralogic "signatures", rock unit information (e.g., formation and member), sedimentological data including type of deposition (e.g., lake beds or river deposits), high or low energy fluvial environment, channel or deltaic deposits, near shore or deep water lake conditions, etc.

2. There is a wealth of **Geospatial data** available for the study area. Digital elevation models (DEMs) will provide a number of derived data layers such as slope, aspect, visibility and curvature. Coupled with GIS maps of roads and trails, an accessibility surface will be constructed that depicts travel times for all areas of the study area. GPS receivers will be used to precisely map locations of fossil localities, trails, roads, and geological features of interest. To boost the accuracy
of the GPS measurements, one receiver will be set up over a benchmark or other
geochemical control as a base station. When the known location of the base station
antenna is input to the receiver, differential corrections are recorded for all
available satellites during a field data collection session. When base station data
combine with data files gathered by the roving receivers the spatial accuracy
increases from the normal 10 – 40 meter level of accuracy for standalone GPS
measurements to sub-meter accuracy in the post-processed output.

3. Two types of Remote Sensing imagery will be used in this investigation. The
Enhanced Thematic Mapper (ETM+) sensor carried aboard the Landsat 7 satellite
produces images that have a nominal pixel size of 28.5 meters for six bands in the
visible, near, and mid-infrared segments of the electromagnetic spectrum.
Landsat 7 images also include a panchromatic band with a 15 meter spatial
resolution—this will be used to “pan-sharpen” the multispectral bands to provide
higher resolution images for analysis of the surficial materials. GPS-referenced
field observations of rock types, lithologies and facies will be used to characterize
the local geological setting of the study area. Image analysis and supervised
classification will be performed on a per-pixel basis using the ENVI\textsuperscript{TM}
software application. Definiens Professional, an advanced object-oriented image analysis
software package, also will be used in this project (Benz, 2001). This type of
analysis works particularly well on high resolution images, so the available GIS
layers of roads and trails will be supplemented by features extracted from 1 meter
resolution, color infrared digital orthophotoquads (DOQQ’s) available from the
Wyoming GIS Consortium.

**Collecting the Field Data**

Funding from the FRACAA program will allow us to bring a field crew comprised
mainly of graduate and undergraduate students from WMU to the Great Divide Basin for a
month long field season during the summer of 2010. During this field season we will collect
detailed geological and paleontological data from a series of fossiliferous deposits (including our
new and extremely productive Locality 222) which will provide the main inputs for our ANN
model, a preliminary version of which was developed during the Spring 2009 semester by
Anthropology graduate student John Van Regenmorter under the advisement of the PI and Co-
PI. Intensive GPS data collecting and description of lithologies, sediments, and paleoenvironments at fossil-bearing localities will provide the “ground truth” component of geological information on the nature of fossil-bearing and barren rock units (Craven, 2006). Rock units and fossil localities will be explored, collected, and described on the ground with the aid of 1:25,000 topographic maps and aerial photos, and differential GPS will be used to accurately (<1-5 m) identify the location of the geological units of interest.

Developing the Predictive Model

We propose to develop an inductive, artificial neural network (ANN) model for locating fossil localities with a high potential for containing mammalian fossil deposits. We will use the existing GIS database developed by the PI over the past 10 years to develop an ANN computational model that iteratively assigns weights to the geographically referenced input “neurons” to match the observed fossil-bearing and sterile localities (An et al. 1995). Artificial neural networks mimic their biological equivalents in a central nervous system in that they are an adaptive form of “learning” (Haykin 1994). ANNs have many forms and levels of complexity, but we propose to use the back-propagation algorithm contained in the ArcSDM3 extension (Sawatsky et al. 2004) to the ESRI ArcGIS™ software package. This type of algorithm uses a series of input nodes or neurons, one or more hidden layers of neurons and output “training” neurons that represent fossil locations. Patterns of features that are common to fossil bearing locations that have been identified on the ground are identified and are used by the model to classify other areas of the study site in a “fuzzy” fashion. The output provides a classification of unvisited sites within the study area along with associated probabilities of these sites being productive. The model will be initially built using detailed geological and paleontological observations collected by the field team during the summer 2010 field season. Based on this data, we will produce a detailed map of the field area during the Fall of 2010 with associated probabilities for the presence of fossil deposits. During subsequent field seasons, we will evaluate the success of the model by detailed searching for fossil mammals in those areas which the ANN indicates have the highest probabilities of containing fossils. External grant applications will be submitted to federal (e.g., NSF) and private (e.g., Wenner Gren, Leakey Foundation) agencies for further development and testing of this predictive model.

Significance of This Project
The need to spatially analyze the complexity of potential fossiliferous areas requires paleoanthropologists to abstract or sample specific characteristics of those areas from the universe of all possible elements of interest in those same areas. Therefore, the tools available to paleoanthropologists enabling them to effectively sample various elements within a landscape conducive to fossil discovery (e.g., geologic, geographic, topographic, sedimentological) help determine, to a large degree, how successful their efforts will be. In other words, for fossil prospecting to be successful, paleoanthropologists need to somehow select appropriate features of the landscape while discarding others. Combining GIS and RS, we propose to develop predictive fossil prospecting models that allow them to do just that.

As paleoanthropological field research moves into the 21st century, its methods and techniques must move there as well in order to maximize the recovery of the non-renewable resources of human paleontology mentioned above. Remote Sensing and GIS are extraordinarily powerful tools that can be exploited by the paleoanthropological community to further their research into human origins. Paleoanthropological fieldwork is expensive, time-consuming, logistically challenging, and often "hit or miss." Any methodologies that help minimize these "negatives", while at the same time making field research more effective and productive, would be an extremely valuable contribution to anthropology in general, and to paleoanthropology in particular. The goal for the proposal is to develop the types of predictive field models that will allow paleoanthropologists to successfully meet those challenges in their field research. The Great Divide Basin is an excellent place to develop and "field test" these predictive models since it is an accessible area whose geology and vertebrate paleontology have been extensively studied over the past decade or so – thus minimizing the amount of time, effort, and resources needed to establish base line GIS and RS data for our models. Once these models have been field tested and "fine-tuned" in the Great Divide Basin, the basic methodology can be adapted to paleoanthropology field sites anywhere in the world. The project team can also envision future work in which elements of the model could be adapted to other types of anthropological fieldwork, such as primate behavior and ecology or prehistoric archaeology (e.g., Jaime, 2006). Thus, this project has the broadest implications for many types of anthropological research, and should be of interest to many anthropologists, geologists, geographers and paleontologists.
Bibliography


FRACAA Budget Worksheet
(each entry under budget category must be identified)

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<td>Field crew of 9 students and colleagues</td>
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<tr>
<td>GIS software costs, contribution to Dept. of Geography site license for ArcGIS</td>
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<tr>
<td>Molding and casting of fossils</td>
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Total FRACAA request** | $10,000.00 |

Attach detailed budget justification.
Detailed Budget Justification

Total Travel Costs = $4580

1. The PI and several team members will travel to the field site in two personal 4-wheel drive vehicles. The distance is 1400 miles each way, for a total of 5600 miles. The current reimbursement rate is $.55 per mile, for a total cost of $3080.

2. The drive to our field site takes 2.5 days each way, which requires us to spend two nights in hotels in both directions. We will need two double or triple rooms each night (there will be 5 or 6 people in our party), for four nights, budgeted at $50 per room, for a total cost of $400.

3. The PI and team members will be eating in inexpensive roadside restaurants during the 2.5 day trip to and from Wyoming, expenses estimated at $50 per day for a total cost of $200.

4. We will be spending 4 full weeks in the field: during the first three weekends, we move to “town” (typically Rock Springs, Wy) for a Saturday night in a hotel (during the week we camp out in the field area). During each of these three weekends, we will book 4 rooms for a single night. Budgeted at $75 per night for a total of 12 rooms, our total cost will be $900.

Total Supplies Cost = $2450

1. Gasoline and oil changes in field. We estimate that our 2 field vehicles will each drive 250 miles for each of the 4 weeks of our field season, for a combined total of 2000 miles. Estimating gas at $3.00 per gallon, and 15 mpg suggests that our gas expenses will total $400. Another $50 is budgeted towards an oil change and new air filter for both vehicles at the end of the field season. Total cost is $450.

2. Food for our field crew of 10 individuals for 4 weeks is estimated at $350 per week (all meals during the week are taken in camp). Total cost is $1400.

3. Miscellaneous camp supplies include fuel for our cooking stoves and lanterns, 5 gallon water jugs, camp chairs and table, coolers, trowels and brushes, tissue paper, etc. Total cost is $300.

4. Fossil storage supplies include glass vials and corks, plastic and paper bags, cardboard trays and plastic boxes. They are needed for proper storage and curation of our fossil collections. Total cost is $300.

Total Equipment Cost = $1470

1. In Focus Design Solo Screens are wire-mesh boxes used to screen the sediments at productive fossil localities. We plan to purchase two in order to have 2 screening teams working simultaneously. At $285 each (includes shipping), the total cost is $570.

2. Two small wet sieve screens will allow individuals to sift sediment looking for fossils within the eroded sandstone deposits that are common at our fossil localities. At $88 each (includes shipping), the total cost is $175.
3. A Garmin GPS unit will be used to collect detailed spatial coordinates at individual localities. The unit we plan to purchase is the Oregon 550t, which has a total cost of $625.

4. A micro-sd storage card is required to store and move data from the GPS unit to computers, and to load additional maps onto the GPS unit. Total cost is $100.

Total Other Costs = $1500

1. GIS software costs. We propose to contribute $1000 to the Department of Geography’s annual site license fee for ArcGIS software. Total cost is $1000.

2. Molding and casting of fossil specimens that we recover can be contracted out to the University of Michigan Museum of Paleontology’s professional fossil preparatory, Dr. Bill Sanders. Creating resin molds and epoxy casts of important fossils is a critical part of the science of paleontology. These casts are often shared with colleagues who are studying the same taxa. Total cost is $500.
April 19, 2010

Dr. Robert Anemone
Department of Anthropology
Mailstop: 5306

RE: FRACAA No. 10-006

Dear Dr. Anemone

Congratulations. The FRACCA Review Board has approved your application for support from the University's Faculty Research and Creative Activities Award for $10,000.00. The Review Board examined 39 applications and this year had funds to support 23 meritorious proposals — including yours. We hope this award will help advance your research, scholarship or creative activities and advance your professional development.

Please note that your acceptance of this FRACCA award carries the obligation by you to submit an external grant proposal within one year. This external proposal requirement supports FRACCA's role in fostering externally funded research activities at the University. Failure to meet this external proposal requirement will make you ineligible for future FRACCA funds.

Two meetings about the award are being set up. You must attend one of the two sessions. You will receive an award agreement at the meeting that you will need to sign and date. This agreement contains the stipulations about your award and includes your project cost center number. This cost center number will be available for your use beginning July 1, 2010. We will notify you of the scheduled meetings when the times are confirmed.

If you have any questions please call Walter Worthy, FRACCA Fund Coordinator in Research and Sponsored Programs at 387-8282. Your colleagues who reviewed proposals were impressed with your proposal. We wish you well in your continuing research endeavors.

Sincerely,

[Signature]

Brooks Applegate, Chair
FRACAA Review Board
NOTICE OF AWARD
FY 2010-2011 Faculty Research and Creative Activities Award

Project Number: 10-006
Project Director: Robert Anemone
Project Title: Using GIS and remote sensing in the search for fossil mammals
Period of Award: July 1, 2010 through June 30, 2011

Award Amount: $10,000
Department: Anthropology
Fund: 23
Cost Center: 0016670
(The account will be activated July 1, 2010)

CONDITIONS

1. Any release of information relating to this award must include the following (or a comparable) acknowledgment of support: "This work was supported by a grant from the Faculty Research and Creative Activities Award, Western Michigan University." Information refers to news releases, program announcements, exhibits, performances, oral presentations, publications (including journal articles), etc. One copy of any resultant publication and/or announcement of performance or exhibit, bearing acknowledgment of support by the Faculty Research and Creative Activities Award, must be submitted to the Fund Coordinator, Research and Sponsored Programs, OVPR.

2. A progress report is due by January 14, midway through the project period. The brief summary (not to exceed 2 pages) should describe the following: (a) summary of work to date; (b) summary of budget expenditures, and (c) any slippages in the project timeline and expenditures.

3. One copy of a final technical report is to be submitted to the Fund Coordinator no later than the termination date of the project. A copy of the Final Report format can be found on the OVPR website.

4. Title to equipment purchased with FRACAA funds vests in WMU with the understanding that such equipment will be used for the specific project. Upon termination of the project, equipment so purchased will revert to the appropriate department/academic unit. (Refer to the final report guidelines for the necessary certification responsibility).

5. Requests for budget revisions, including a justification, must be submitted in writing to the Fund Coordinator. All such requests must be submitted as early in the project period as possible, but no later than 90 days prior to the project termination date. All project expenses must be incurred prior to the termination date and must be charged to the project fund and cost center within 90 days of the termination date (i.e., if the termination date is 6/30/2011, all expenses must have been incurred by this date and be charged by 9/30/2011). No new expenses can occur after the termination date. All monies remaining unexpended 90 days after the project termination date will automatically revert to the FRACAA account.

6. FRACAA awardees requesting project extensions must make the request no later than 60 days prior to the project termination date, with a fully justified explanation. The maximum amount of time allowed for a project extension is until the end of the fall semester following the original June 30 termination date.

7. In the event that the project director's appointment at WMU terminates during the period of award, either (a) the project must be completed as proposed and all requirements of the final report satisfied, or (b) all unused funds will be swept by OVPR and returned to the FRACAA account. In such cases the recipient must notify the FRACAA Fund Coordinator within 10 days of the decision to leave WMU, with an explanation regarding the intent to pursue either option A or B described above. Any equipment purchased with FRACAA funds remains the property of WMU.

8. If the activity involves the use of human subjects, human materials, vertebrate animals, radiation, or recombinant DNA, it is necessary to obtain appropriate review and approval prior to the account being activated.

9. Non-compliance with any of the conditions pertinent to this award could adversely affect future eligibility for support from the fund and/or result in other penalties. Faculty should be knowledgeable of all relevant University policies, available on the WMU and OVPR websites.
10. Recipients are required to present a poster or display at WMU Research and Creative Activities Day held each spring.

PROCEDURES

1. The accounting office has assigned a Fund and Cost Center to your project. This number must be used for processing all expenditures under this project. Questions pertaining to requisitions, purchase orders, and/or payment requests (vendor, payroll, travel, etc.) should be referred to your department. Accounting information for your project is available through the general ledger operating web (GLOW). GLOW is located at the World Wide Web address http://www.fs.wmich.edu/glow. It is the responsibility of the project director and the department to maintain an accounting of the FRACMA funds awarded for this project.

2. All expenditures under this grant must conform to WMU policies.

PLEASE READ CAREFULLY BEFORE SIGNING.

The funds from this cost center are to be used only for this award. Funds other than those awarded by means of this notice may not be added to this cost center. Funds awarded by means of this notice may not be used for purposes other than those specified in the proposal. Should funds from any source other than the award be added to this cost center or should award funds for this project be expended on any other project, the award will be terminated, all funds will be withdrawn from this account, and all future proposal submissions will be denied.

[Signature]

ACCEPTED BY

[Signature]  
[Date]  

Rev. 6/2/2010 - OVPR
# FINAL REPORT

Faculty Research and Creative Activities Award  
(FRACAA)

<table>
<thead>
<tr>
<th></th>
<th>RSP Use Only</th>
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<tbody>
<tr>
<td>1.</td>
<td>Proposal No: 10-006</td>
</tr>
<tr>
<td>2.</td>
<td>Name: Robert L. Anemone</td>
</tr>
<tr>
<td>3.</td>
<td>Department: Anthropology</td>
</tr>
<tr>
<td>4.</td>
<td>College: Arts and Sciences</td>
</tr>
<tr>
<td>5.</td>
<td>Project Title: Using GIS and Remote Sensing in the Search for Fossil Mammals</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>6.</th>
<th>Summary of the project (i.e., purpose; results and successes; outcomes, such as publications, exhibitions, proposals for external funding). Limit to the space below.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The purpose of this funding was to utilize new approaches from the geospatial sciences in order to develop a predictive model to aid in the search for fossil mammals in the Eocene of SW Wyoming. The funding supported a field season in Wyoming during August 2010 during which we collected requisite field data. Lab analyses followed during the Fall semester 2010, during which I had a one semester sabbatical. Three manuscripts have been completed and submitted to peer-reviewed journals as a result of this funding, one of which has already been accepted and is “In Press” (see list below). In addition, I presented on this research at an invited session at the annual meeting of the American Association of Physical Anthropologists in Minneapolis during Spring semester 2011, and will also be presenting on this research in Las Vegas during Fall 2011 at the annual meetings of the Society for Vertebrate Paleontology. Current plans are to develop a major grant proposal based on this preliminary work for submission to NSF in collaboration with Jay Emerson of WMU’s Geography Department and Glenn Conroy from Anatomy and Anthropology at Washington University. This proposal will also build upon the NSF-funded fieldwork I took part in during May-June 2011 in South Africa and will seek to develop our predictive model for paleoanthropological sites relevant to human evolution in southern Africa.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Publications:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>RL Anemone</strong>, CW Emerson, GC Conroy (submitted) Finding Fossils in New Ways: An Artificial Neural Network Approach to Predicting the Location of Productive Fossil Localities. Evolutionary Anthropology.</td>
</tr>
</tbody>
</table>
7. This item MUST be completed if equipment was purchased with FRACAA project funds.

I certify that all equipment purchased with FRACAA project funds has been returned to my department.

(Signature)  6/28/11  (Department Chair's Signature)  6/28/11

(Date)  (Date)
I am happy to report that my 2010 FRACAA-funded project entitled “Using GIS and Remote Sensing in the Search for Fossil Mammals” was extremely successful in a number of significant and measurable ways. The funding provided by FRACAA enabled me to bring a field crew comprised of several professional colleagues, as well as undergraduate and graduate students to our field area in southwestern Wyoming for a productive field season in late August and early September of 2010. We collected approximately 1000 fossil mammals from a number of different localities, and collected GPS data from each of these localities for use in our ongoing development of predictive modeling approaches to aid in the search for fossil mammals. We were joined in the field by my colleague Jay Emerson from WMU’s Department of Geography, with whom I have been collaborating on this project, and who helped train our students in the theory and use of GPS equipment in the field.

The main positive result of our work has been the completion and submission of three manuscripts to leading peer-reviewed journals\textsuperscript{1-3}. In addition, during the Spring of 2010 we presented the results of our work at an invited symposium at the 2010 annual meetings of the American Association of Physical Anthropologists\textsuperscript{4} and at a session of the 2010 meeting of the Association of American Geographers\textsuperscript{5}. We have recently submitted an abstract to present our latest results at the Fall 2011 meetings of the Society for Vertebrate Paleontology\textsuperscript{6}.

An unexpected but welcome benefit of my work in this area was an invitation to join an NSF-funded international crew of biological anthropologists and geologists for 3 weeks of field work in South Africa during May and June of 2011. The goal of this fieldwork was to collect GPS data on a series of new Plio-Pleistocene fossil localities in order to attempt to apply our FRACAA-funded model for locating fossil mammal localities developed in Wyoming, to the search for early human fossils in Africa.

I am currently collaborating with Dr. Emerson and several other colleagues to develop one or several proposals for external funding of the further development and field-testing of our ongoing work to develop predictive models of the location of productive fossil-bearing localities using GIS, GPS and remote sensing.
Works Cited


2. RL Anemone, CW Emerson, GC Conroy (submitted) Finding Fossils in New Ways: An Artificial Neural Network Approach to Predicting the Location of Productive Fossil Localities. Evolutionary Anthropology.


### Revised Final Budget

<table>
<thead>
<tr>
<th></th>
<th>Budgeted</th>
<th>Actual Expenditures</th>
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<tbody>
<tr>
<td>Travel Costs</td>
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<tr>
<td>Supplies Costs</td>
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<td>$1627</td>
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<tr>
<td>Equipment Costs</td>
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<td>$767</td>
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<tr>
<td>Total Other Costs</td>
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<td>$1000</td>
</tr>
<tr>
<td>Additional Items</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poster Production for FRACAA Poster Day</td>
<td></td>
<td>$222</td>
</tr>
<tr>
<td>CT scanning of fossils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At UT-Austin facility(^1)</td>
<td></td>
<td>$565</td>
</tr>
</tbody>
</table>

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\(^1\) Rather than spend the $500 budgeted for molding and casting of fossils, we decided to spend this amount having some extraordinarily important new primate fossils scanned at the micro-CT facility at UT Austin, in collaboration with my colleague Brett Nachman from UT-Austin’s Department of Anthropology. We have recently been able to have our important fossil specimens molded and cast for no cost as a result of our collaboration with Dr. Chris Beard from the Carnegie Museum of Natural History in Pittsburgh, PA.