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The *bioMovies* Project: Developing interactive digital video for active learning environments

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Marianne Niedzlek-Feaver is an Associate Professor of Zoology at North Carolina State University. She received her Ph.D. in Zoology from the University of Michigan, and she studies the factors most important in shaping the mating systems of grasshopper and katydids. She currently teaches courses in Introductory Biology, Invertebrate Biology and Evolution. She has obtained funding for laboratory equipment and authored software that extends the laboratory experience, and is a member of the Academy of Outstanding Teachers at North Carolina State University.

Dr. Betty L. Black received a Ph.D. from Washington University in St. Louis, and is currently a Professor in the Department of Zoology at NCSU. Her research involves hormonal and nutritional control of developing intestine, and she teaches Developmental Anatomy and Histology courses, plus an internet distance education course, Functional Histology. She recently received a University award for “Innovative Excellence in Teaching and Learning with Technology.”

Harold Heatwole is an ecologist with a Ph.D. each in Zoology and Botany, and a D.Sc. in Herpetology. His research encompasses both invertebrates and vertebrates, and it has taken him to all seven continents. He is one of the foremost authorities on sea snakes, and has edited two multi-volume series: Amphibian Biology; Ecology in Australia. He currently teaches courses in Animal Diversity, Herpetology, and Desert Ecology, and has organized field courses to the Great Barrier Reef, the Galapagos, Antarctica, and Africa.

Introduction

This paper introduces an effort to develop and distribute high quality digital video with interactive features for enhancement of learning in biology. The *bioMovies* project is supported by an Academic Challenge Grant from the United States Department of Agriculture. Another objective of this paper is to discuss ways that readers can join the Biomovies effort by initiating their own projects.

1. *bioMovies*

Biology, more than other sciences, is a visual experience. In this age of technology we need to explore ways to modernize our illustrative material. Animals run, slide and slither; they should do likewise in our lectures or on our websites. And they should do so in a meaningful way so our visuals truly exemplify basic principles.

The *bioMovies* project was initiated by three faculty of the Zoology Department, North Carolina State University, who were frustrated by failed attempts to provide excellent visual aids in the face of shrinking academic budgets. The project has as its primary goal the development of “smart” movies, essentially digital video clips, that allow academics to pepper their lectures and laboratory experiences with high quality illustrative video. Some of the videos incorporate explanatory audio, text or diagrams, and/or utilize interactive features such as moving arrows, pop-up labels, 3-D rotation and animation (Figs 1-3).

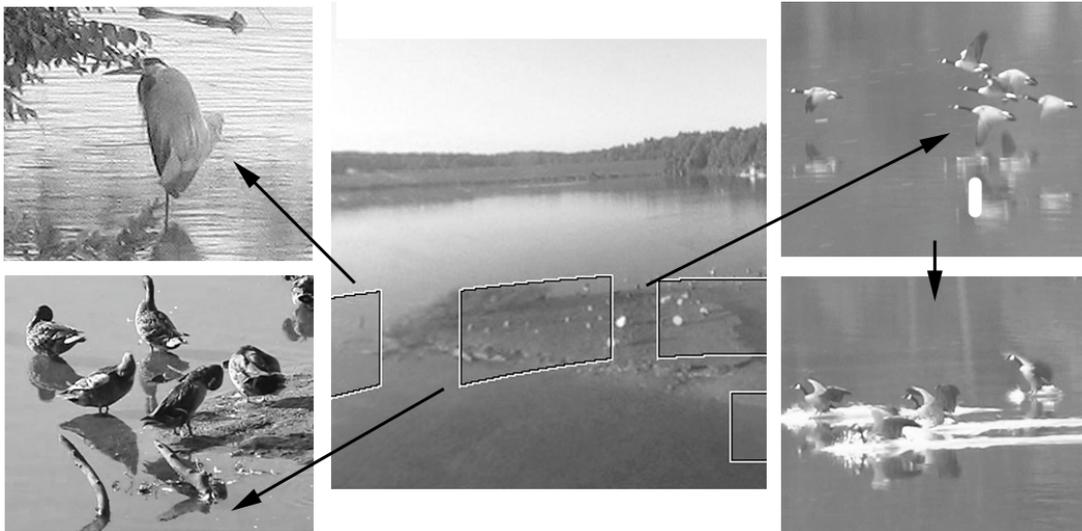


Figure 1. Scene from a panorama in which students can with a click move to additional footage which shows Canada geese landing, cranes feeding or ducks grooming.

Figure 2. Students can ask for arrows that point out different bones or move from one part of the skeleton to another.

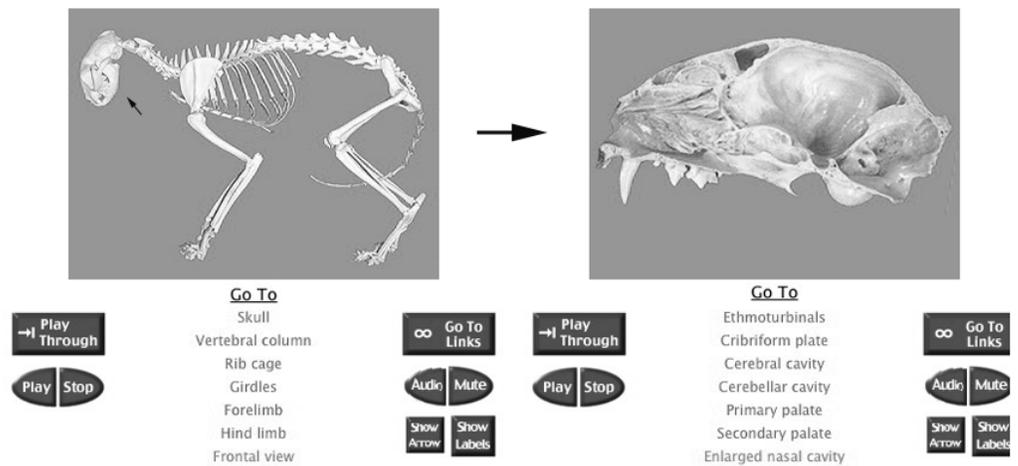


Figure 3. Students in this clip that addresses competition between woodpeckers and starlings, can compare the distribution of the two species involved.



Starling



The Red-bellied Woodpecker
Melanerpes carolinus

The woodpecker is a native North American bird.

The Common Starling
Sturnus vulgaris

The starling was introduced to America from Europe

▶ || Click on hotspots above to view pictures and distributional maps.



Red-bellied woodpecker



Movies feature invertebrate and vertebrate animals and natural habitats that range from local (North Carolina) to worldwide (Antarctica, deserts, tropical rain forests and coral reefs) (Figs 4 & 5). Movies can be used to illustrate and test for understanding of how animals move, feed, or develop. Life history and ecology as well as structure/function relationships of selected species are treated. Some basic laboratory techniques are also examined such as use of a microscope, or micropipette (Fig. 6).



Figure 4. An Australian platypus. Figure 5. A Tibetan yak. Figure 6. How to use a micropipette.

All our videos are compressed so they can be delivered on CDs for use in computer-equipped laboratories and multimedia lecture rooms. The movie format is Quicktime which runs on Macintosh and PC computers (the Quicktime player is a free download from Apple's website). Since the user interface is html and works with any web browser, the shorter videos may also be placed on course web sites for student use outside the classroom. A selection of short clips plus two examples of interactive movies may now be downloaded from the *bioMovies* web site (<http://ncsu.edu/biomovies>) and longer interactive videos are available on free CDs (see below for a listing of contents). Please send requests for CDs to Dr. Betty Black.

Those receiving CDs will be asked to review contents and fill out a questionnaire available online (<http://ncsu.edu/biomovies>). We welcome suggestions from all readers regarding types of subject matter of greatest interest and types of interactive format most desired for future products. Please feel free to email any of the authors of this paper.

Content of CDs

Volume 1

INTRODUCTORY MOVIE – video explaining the *bioMovie* project and future marketing plans

SHORT CLIPS – 20-80 sec. videos, sorted by animal group

- Invertebrate animals
- Fish
- Amphibians
- Reptiles
- Birds
- Mammals

INTERACTIVE MOVIES – longer clips with interactive features

- Cat coat color
- Predation and camouflage in aquatic animals
- Seahorses
- The platypus
- Wallaby care of young
- Woodpecker and Starling: interspecific competition
- Protozoans
- Anatomy of the cat skull

INSTRUCTIONAL VIDEOS – laboratory procedures

- Using the pipette
- Preparing a gel for electrophoresis

Volume 2

(Consists of two CDs)

INTRODUCTORY MOVIE – same as on original CD

SHORT CLIPS—20--80 sec. videos, sorted by animal group (all new)

- Invertebrates
- Fish, Amphibians and Reptiles
- Birds
- Mammals

SHORT FEATURES

Marine Iguana (Filmed in the Galagagos Islands; 9 min., narrated video) Depicts the distribution and variation of the marine iguana, and illustrates its feeding, thermal regulation, osmoregulation, and relation to humans.

Flightless Cormorant (Filmed in the Galagagos Islands; 6 min., narrated video) Treats the behavior of flightless cormorants, including locomation, diving, social behavior, preening and nesting.

Yaks (Filmed in Yunnan, China and Tibet; 2 min., narrated video and still images) Briefly

describes the characteristics of yaks and their use by humans.

Wildlife at Shelley Lake (Filmed in Raleigh, NC; Panoramic movies with linked video clips)

Uses panoramic movies with "hotspots" to illustrate the lake environment and its avian and turtle inhabitants. Take a walk over the lake bridge to watch ducks, geese, herons, a kingfisher and a turtle going about their daily lives. Can be used as a virtual field trip.

2. The recipe for a *bioMovie* clip.

We have learned a bit about what works and what doesn't, and wish to help others contemplating a similar project by sharing our experiences. We chose mini DV as the capture media. The tapes are relatively cheap (see Appendix). Research revealed that some consumer grade camcorders could be modified for use on microscopes and/or use with proper housing for underwater video.

Cameras and computers

We already had one reasonably priced microscope camera that provided live video input into a computer and two digital Nikon 900 cameras that could be used for any stills needed. We decided to use grant funds to purchase a consumer high-end or studio low-end mini DV camcorder (Canon XL1) because of its ability to zoom and therefore capture animal footage at some distance from the subject. Additional funding for a distance education course using smart clips allowed us to purchase a second Canon recently. The upgraded model, Canon XL1-S, is a bit lighter and more suitable for fieldwork.

We were fortunate that one of the authors travels extensively in conjunction with his research. For most trips he takes the Canon camcorder. Initially this camera was shipped as luggage in a protected traveling case. However, several mishaps now has Dr. Heatwole traveling with the camera on his arm as his carry-on luggage. Be forewarned that fieldwork is as taxing on cameras as it can be on an investigator. Our Canon camera has been repaired twice (leading to a significant elay in production); we advise insurance for loss or damage.

All camcorders purchased interface with our computers via FireWire. The smaller Canon Optura and Panasonic camcorders also accommodate SD memory cards for still images. Our still digital cameras store their images on compact flash cards. Although images can be downloaded into a computer directly from the camera, this can be a time consuming process and we recommend the purchase of a card reader.

Our teaching laboratories contain Macintosh computers. We utilize the Macintosh as a production platform, although most of the software is also available for the PC platform. Projects or collections of downloaded video that may be used to produce a *bioMovie* can take up a lot of storage space, so additional hard drives may be required. Archiving original video or finished movies

requires additional, permanent, storage space. For works in progress, we use portable hard drives that provide both additional space and a convenient way to transport projects between office and home. For archives of completed movies and video obtained directly from the Sony microscopy camera, we have used both DVD disks (4.3 GB capacity) and a large external hard drive. We do not save copies of original video downloaded from mini DV tapes, but duplicate the most valuable tapes using a Sony tape player.

Capturing and editing clips of interest

Sequences of interest on a tape must first be downloaded into some kind of video editing program. We have used iMovie (provided by Apple with purchase of a new computer), Premiere (Adobe) and Final Cut Pro (Apple). In conjunction with QuickTime Pro, iMovie should be sufficient for most users initially. The more sophisticated editors allow tapes to be logged; selected sequences can be downloaded automatically in batches. We currently use Final Cut Pro for this purpose. The application 'BTV' was used to collect direct DV footage via the Sony camera that delivered video directly to the computer. BTV is not an editing program, but provides ability to control camera functions such as shutter speed and gain, can capture video or still images from video frames, and allows for choice of compression during capture. Additional software for FireWire cameras is now available (see for example <http://www.outcastsoft.com/ASCASTROIIDC.html>).

Once video has been downloaded to the computer, a video editing program is used for basic editing, such as the removal of unwanted footage within a desired clip, the stitching of clips together, and addition of audio narration. These editors can also be used to create titles and add some animation features such as moving arrows, but we have used these features sparingly. Since our desired format is QuickTime, we export edited videos as QuickTime movies. Finally, we compress the movies using the application 'Cleaner' in conjunction with 'Sorenson Pro' which, in our hands, gives optimal quality with the low data rate and small file size required for distribution via CD. Most users would probably find the compression options provided by editing programs to be adequate. Quicktime Pro, available from Apple at low cost, also has some basic editing and compression features useful for developers and users alike. For example, consumers of our products could use Quicktime Pro to remove unwanted audio tracks or to shorten our movie.

We have used several approaches to make movies interactive. Adobe GoLive, known as an html editor and web site builder, includes a QuickTime editor that can be used to add a variety of interactive features. Using the QuickTime editor, we place the compressed movie into a larger frame movie and add additional tracks. Within 'GoLive,' text and picture tracks as well as additional audio and video tracks can be added to the timeline of the existing movie. Added "sprite" (or action) tracks give us our basic controls, as well as providing moving arrows, "pop ups" and links to other movies or outside web sites. We have also used GoLive to add "chapters" to our movies, which allows sequences within the movie to be selected from a pull-down menu in the QuickTime play bar. "Hotspots" within the original movie are difficult to create in GoLive, but can be added easily via another application, VideoClix. These "hotspots" become sprites when the resulting movie is imported into GoLive, and can be used as additional links or controls. VideoClix can also be used to add chapters, but we found that the chapter track did not translate well when imported into GoLive. We also use GoLive to build the user interface for *bioMovies* Cds, which is a "webpage" with links for accessing the movies.

Panoramic and object movies

The development of panoramic or object (3-D) movies requires a different type of approach. Object and panoramic movies traditionally were made by taking pictures sequentially that were then stitched together into a seamless movie in which the viewers orientation could be controlled by the mouse. New technology allows a 360° panoramic image to be obtained with one click of a camera outfitted with a special mirror or panoramic optic (see <http://www.0-360.com>). Apple QVTR and more recently VRWorx (VRToolbox) can be used to add hotspots to the resulting movie. We have used this technology to create our first panoramic movie, “Wildlife at Shelley Lake,” in which hot spots within the panorama link to close-up videos of ducks, geese, herons and turtles (Fig. 1).

Stabilization

We have also accumulated software to rectify some problems we encountered. For example, filming requires a steady hand or a tripod. It is difficult for one person to carry both a tripod and camera; our initial attempts to do without a tripod yielded video that was jerky and needed stabilizing. Recently we found a program, iStabilize, that works well and is very reasonably priced.

Basic resources needed

In summary, “smart” Quicktime movies can be made for a modest investment, requiring initially only a consumer camcorder, a computer, video editor and software for adding interactivity (we recommend Adobe GoLive). As with any venture, initial success fuels the ever-growing desire to produce material that is more sophisticated. We have experimented with more sophisticated software/equipment and the materials/software required to make panoramic and 3D movies. Our next experiments will probably involve the integration of animation. One of the authors has obtained Carrara (Eovia), a 3D modeler and basic animator that can produce Quicktime movies as products. Other authors are working with the NCSU distance education staff to produce suitable animation for *bioMovies* as well as for a new Distance Education course in Animal Diversity.

Our final word of advice: You cannot have enough storage media or hands! We deeply value the effort of the numerous undergraduates who have helped make this project a success. We welcome as always your questions and other input. Please share your experiences with us. We also invite collaboration. Those wishing to discuss collaborative effects should contact one of the authors.

Appendix – Equipment

Digital video

- Cannon XL1S or XL2 mini DV camcorder (\$3,500—5,000 depending on lenses)
- Cannon Optura or Panasonic mini DV camcorder (\$600--800)
- Sony Firewire camera--live video input to computer (\$500—1,500 depending on frame size)
- Fire-I 400 industrial camera (Unibrain \$480) Recently purchased for classrooms. Equivalent of Sony camera. Delivers movies of size 640 by 480 pixels.

Digital still

- Nikon 900 (\$1000)
- Cannon G5 Powershot (\$400)
- Copystand for camera (\$ 500)

Computers and peripherals

- Apple G5 computer (\$1,500—3,000)
- JVC or Sony miniDV tape player (\$800-1,100)
- Firewire drive--extra storage and transport of large files (\$1 per GB)
- Epson printer with attachment to print CD labels (\$400)

Software (Academic pricing at <http://www.academicssuperstore.com>)

- Final Cut ProHD--includes an audio editor, QuickTime Pro and compression features (academic pricing varies from about \$400 to 1000)
- Final Cut Express-- includes an audio editor, QuickTime Pro and compression features (\$99 to 150 at NCSU store)
- QuickTime Pro--includes audio and video compression features (\$30)
- Adobe Photoshop (\$280)
- Adobe Photoshop Elements--an acceptable alternative to Photoshop (\$130)
- Adobe GoLive (\$75)
- Cleaner 6 with Sorenson pro codec (\$180 + 170)
- Sorenson Squeeze—an alternative to Cleaner (\$220)

Note: Cleaner and/or Sorenson squeeze are needed for optimal compression using the Sorenson Pro codec, but compression using Final Cut or QuickTime Pro would be acceptable to most users.

Specialty equipment and software.

- Card readers. Various brands. Models are available that do a variety of different storage media. (\$20-50)
- 0-360 panoramic optic (0-360.com.---\$595): parabolic mirror, fits on some 5 mega pixel still digital cameras and allow the capture of a full panoramic shot in one picture. Zero 360 UnWrapper software takes the donut shape picture produced and turns it into a linear sequence (included with optic).
- Quicktime VR (Apple). The production of panoramic and object movies from still and video. “Scenes” or complex panoramic or object movies can be produced by the addition of hotspots that link the first movie accessed by the viewer with other media, stills, movies or URLs. Most of the object movies produced to date have been made with QTVR. (\$395)
- VR Worx (VR Toolbox.com.) The production of panoramic and object movies. We use it primarily with system X to adds hot spots to our panoramic and object movies.
- istabilize. Dedicated stabilization software. Has a very easy interface and is reasonably priced. (\$35)
- Turntables. Used for making object movies. Lazy Susans can be modified. We have purchased a small manual adjusted turntable from Kaiden.com (\$90).

Supplies

- Mini DV tapes (\$3.00-6.00 ea)
- CDs with printable surface (\$25-30/100)
- DVDs for archiving (\$30-50/100)

Labor

- Student labor (we paid ~\$8/hour)
- Often students were unpaid and received academic credit.