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TECHNIQUES OF VIDEOTAPING FISHES FROM ABOVE THE SURFACE OF THE WATER

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BACKGROUND

Reighard (1910) described methods of making direct observations with the aid of underwater viewers and still cameras for studying the habits of fishes in the field. Other researchers (e.g. Hankinson, 1932; Lachner, 1946; Raney, 1940), using similar devices, plus their keen observations, made significant contributions in documenting the behaviors of freshwater fishes. However, direct field observation (with note taking) and still photography fail to allow researchers to review and analyze the subtle actions that occur in behaviors. Motion picture photography (cinematography and videography), on the other hand, allows one to review and analyze behaviors repeatedly, although the method has some of the same technical and logistical problems that faced Reighard. Raney (1940) clearly states some of the problems in using filming techniques to study the behaviors of fishes:

> Some methods of observation used in studying the habits of other vertebrates have been used 'in fishes' but with the variations and modifications demanded by the aquatic habitat. Thus the camera may be utilized but only rarely from the confines of a shelter or so-called 'blind'. Adverse conditions as too great depth, excessive turbidity, and surface reflection make it impossible to observe successfully much of the time when fishes are spawning. Some early work 'with the camera' on breeding habits is practically worthless because of the uncertainty about the identity of the species of fish seen.

More recently, some researchers (e.g. George, 1980; Collins et al., 1991) have utilized underwater video cameras (using either visible spectrum or infrared lights) with varying degrees of success to document activities of fishes in the field. Few biologists, however, have successfully taped the activities of fishes in streams from above the surface of the water. Prior to our use of frame-by-frame analysis of videotapes beginning in 1986, not a single author had reported 20 conspicuous reproductive behaviors that we now have identified and categorized into sequences of behavior for over 35 species of cyprinids and catostomids in 375 hours of recordings.

This paper describes the cameras, recorders, lighting sources, camera techniques, recording methods, and analytical techniques that we have used to videotape reproductive behaviors of fishes from above the surface of the water.

EQUIPMENT AND TECHNIQUES

Cameras, Recorders, and Power Supplies

Two types of color video cameras are used. One, a 3-chip camera (Charge Coupled Device, CCD, resolution = 520 lines), is equipped with a 12x zoom lens (focal length = 10-120 mm). This manually focused CCD camera has three internal filters (3200 , 5600 +1/8 Neutral Density, and 5600), an automatic/manual iris diaphragm, and three light gain boost settings (0, 9, and 18 decibels, db). The second is a Nuvicon tri-tube camera (resolution = 350 lines) equipped with a 12x zoom lens (focal length = 10.5-126 mm) and an automatic/ manual iris diaphragm. Each camera is operated on a tripod equipped with a fluid head for making vertical and horizontal maneuvers smoothly from one target area to another.

CCD camera images are recorded on professional quality 20-min 3/4-inch videotapes using a portable, NTSC color 3/4-inch video signal system cassette recorder (recording speed = 9.53 cm/sec). During night, the Sony CCD camera may be operated at a light gain of 18 db. Fourteen rechargeable 12-V batteries (charge life = 1 hr each during continuous use in daylight) are required to supply power to the CCD camera and recorder for 14 hr. At night, battery life is decreased to 0.5 hr per battery as the db setting is increased to photomultiply the visual signal. Images generated from the second camera are recorded on 2-hr industrial 1/2-inch tapes using a portable, NTSC color 1/2-inch video signal system cassette recorder (recording speed = 3.34 cm/sec).

Camera Techniques

We incorporate the five cinematographic techniques (camera angle, continuity, cutting, close-ups, and composition), discussed by Mascelli (1965) to videotape activities of fishes.

Camera angle: Camera angle is the position of the camera that is required to view objects, their movements and setting (Mascelli, 1965). Of the three camera angles (objective, subjective, and point of view) we use the objective one to present the activities of fishes from a sideline viewpoint, as **in**

the eyes of an unseen observer.

Continuity: Continuity is the continuous logical flow of visual images in time and space, supplemented by sound, which depicts events in a coherent realistic manner (Mascelli, 1965). We employ an organized shooting plan (i.e., outlines, story boards, or detailed shooting scripts) to avoid shots of unrelated subjects, although at times, we must adapt to the conditions required by the action and circumstances in the field.

Two filming techniques (master scene and triple take) are employed to achieve continuity. The master scene technique (continuous recording of events in chronological order) is used to film sequential behaviors. It is preferred over the triple take technique until a camera operator learns the possible sequences of behaviors that may occur. The triple take technique gives shot-to-shot continuity, from a long shot to a medium shot, and finally ending in a close-up. It collapses continuous activities into small parts to illustrate detail and relativity to the whole. A camera operator must think back to the last shot before filming the present shot, and also ahead to the next shot.

Directional continuity (e.g. map direction, entrances and exits of fishes) is the direction in which subjects are moving relative to a given point of reference. For example, a wide shot of fishes swimming upstream over a nest (facing left in the camera) followed by a sequence where close-ups of fishes are facing right, breaks directional continuity, and confuses the viewer as to the actual direction of the stream. In an editing studio, we also use various electronic transitional devices (fades, dissolves, wipes, sounds) to bridge time and space, while still maintaining clarity of continuity.

Cutting: Cutting, synonymous with editing, is the physical or electronic removal of extraneous film or tape not pertinent to the main topic (Mascelli, 1965). Although cutting is performed in the studio, we did not depend on a studio editor's skill to correct avoidable mistakes made while in the field once we understood editing from a visual, rather than a technical standpoint. Our first cuts are made in the field, where we decide what and when to edit (turning the camera off and on) during taping of scenes. Under special circumtances, we cross cut scenes (="back at the ranch", Mascelli, 1965), to parallel edit two or more events in an alternating pattern to compare and contrast behaviors among species.

Close-up: Close-up, a device unique to motion pictures, allows large-scale portrayal of a portion of the action (Mascelli, 1965). It transports a viewer into the scene, eliminates all non-essentials momentarily to isolate the significant activity, and adds visual clarity and dramatic impact. As there are no substitutes for experience in videotaping, nor for familiarity of behaviors of fishes, we have learned to anticipate sequence in behaviors, and document them by matching the camera angle and size of a close-up of one behavior with that of another.

Composition: Composition is the arrangement of pictorial elements to form a unified harmonious whole (Mascelli, 1965). Compositional principles and elements (e.g. balance, centering, movement, position) are the most pliable of all cinematographic rules and techniques. Our primary compositional priorities are centering and position. For example, fishes at the center of a screen dominate a scene and keep the viewer focused. The position and movement of a fish are shown relative to the setting during a particular activity (e.g. upstream movement of a fish from one location to another within a behavioral sequence).

<u>Recording Methods</u>

The clearest pictures are obtained in calm, shallow (0.1-0.5 m deep), tannin- and turbidity-free streams. Videotaping is performed where illumination (sun or artificial lights) is at right angles or in back of cameras. Cameras are placed in the stream or along its bank, generally within 15 m of fishes. Cameras, without polarizing filters, usually are positioned on a stream bank at an angle of 45° to minimize light reflection from the surface of the water. Camera position alone can be used to effectively reduce reflected light by 100 percent. Polarizing filters are fixed to camera lenses to eliminate residual reflected light as the sun moves overhead, and as fishes change positions.

Filming from an elevated bank (>3 m) yields a vantage point where all activities that occur within 50 m from the camera can be recorded. With a 12x zoom lens, filming within 3 m of the target yields a detailed account of activities yet limits the field of vision to within 10 m of the target. At lower camera elevations, glare increases as the angle of incident light increases.

<u>Lighting</u>

The most lucid pictures are obtained in full sunlight. Partial shadows of tree branches, or those that move back and forth over fishes, not only cause uneven lighting that impede detection of detail, but are distracting as they break continuity. Uneven surface flows created by riffles or partially submerged objects that increase glare can be reduced effectively to laminar flows by placing a seine, brails or logs upstream of the target to optimize picture clarity. The vantage point of the camera is modified to accommodate changes that occur in available sunlight, incidence of reflected light, and positions of fishes.

Adverse weather conditions can preclude videotaping. For example, fog and light rains reduce visual clarity, distort images, as well as can damage electronic components of video equipment. We have, however, used 3 mil plastic to cover all camera parts except the lens during a sprinkle. Whether in open or tree-lined streams, wind can cause ripples in the water that distort images, and diffract and reflect light beyond the planar capabilities of polarizing filters.

Non-intrusive light systems (e.g. infrared and image intensifiers reviewed by Collins, et al., 1991) are not required for making observations and videotaping fishes at night. Two 12 V battery powered halogen spotlights (each 1-million candle power), equipped with rheostats, provide sufficient illumination for us to observe and videotape activities in the dark. Activities of fishes continue uninterrupted as light intensities are increased to maximum output with rheostats

(Maurakis et al., 1995). The brightness of the lamps limits the need for the photomultiplier on the CCD camera. Previously, we had used two 7.5 V incandescent spotlights (each 100,000 candle power) without rheostats for illumination at night; however, the lower intensity of these lights required that the camera be operated constantly at 18 db, which reduced battery life.

Review of Videotapes

In the laboratory, field videotapes are copied, and catalogued according to species, collection number, locality data (country, state, drainage, locality, and date), and tape number. Copies of tapes are played repeatedly in normal speed, slow motion, frame pause, and single frame advance. Tapes are viewed on a 25-inch screen color television monitor to identify behaviors. Tapes are analyzed according to Sabaj's (1992) four part review. Activities associated with a particular nest are reviewed in their entirety at normal tape speed to identify subjects and behaviors (individual fishes are readily identifiable). A tape is replayed with pauses for note taking. Activities of fishes are described and divided into a chronological sequence of episodes. A single episode consists of a particular behavior (e.g. nest-reworking) expressed by a single fish (e.g. dominant male). Episodes directly related to activities of short duration (e.g. spawning, 1-2 sec) are replayed at normal speed, in slow motion, and frame by frame. Orientation of fishes to each other is determined at this time. The entire tape is reviewed again at normal speed to confirm previous observations. These are compared with field notes and video recordings of the diurnal and/or nocturnal behaviors of the species from other localities.

CONCLUSION

If environmental conditions permit, videotaping from above the surface of the water with proper equipment enhances the power of observation by focusing on a particular event. Tape recordings provide an opportunity to identify and review specific behavioral episodes (Maurakis et al., 1991). Videotapes serve as permanent records, and allow frame-by-frame analysis of behaviors of individuals, and interactions within or among species. Species-specific behaviors can be used as effective management tools in preserving habitats of species (McNeely et al., 1990), as they directly relate to the habitat requirements of species.

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