# Fish Enumeration Using Underwater Video Imagery
## - Operational Manual -

Originally
Prepared by:
Bryan L. Nass
LGL Limited
environmental research associates
3736 Riverbottom Road
Ellensburg, WA  98926

Prepared in 2007 for:
**Confederated Tribes of the Colville Reservation**
**Fish & Wildlife Department**
**25B Mission Road**
**Omak, WA 98841**

Revised by
Sonya Schaller
January 4, 2013

TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF PHOTOS

## SUMMARY

The Confederated Tribes of the Colville Reservation (Colville Tribes) are using underwater video systems to count anadromous salmon at strategic locations in the Okanogan basin as they migrate to upstream spawning areas. The video method involves the use of a Digital Video Internet Protocol (DV-IP) server to collect imagery of fish passing through a custom-designed video chute. Specialized underwater cameras located in the video chutes transfer constant imagery to the DV-IP server. The DV-IP server stores a log of fish passage events, captured by motion detection, which are reviewed remotely by Colville Tribes' technicians and converted to numeric data for analysis. Video data is primarily collected to enumerate spawner escapements into specific areas of the Okanogan River basin, although a variety of secondary data, such as run timing, movement patterns, fish distributions, origin, etc. can also be collected. In 2006, the Colville Tribes completed the installation of a video array at Zosel Dam in Oroville, WA. In 2009, the Colville Tribes completed the installation of video arrays in three tributaries of the Okanogan River; Ninemile Creek, Antoine Creek and Salmon Creek.

## BACKGROUND

In 2005, as part of the Okanogan Basin Monitoring and Evaluation Program (OBMEP) to promote the recovery of Pacific salmon and steelhead populations, the Colville Tribes initiated a project titled the "Design and construction of video detection systems in the Okanogan River Basin to enumerate adult salmon and steelhead" (hereafter called the OBMEP video project) to provide census counts at strategic locations throughout the Okanogan River basin. The goal of this program is to enumerate adult salmonid species at several key locations in the basin in order to determine basin and tributary specific spawner distributions, and to evaluate the status and trends of natural salmonid species production in the basin. The target species of this study include anadromous forms of Salmonidae that have known production in the basin, including summer steelhead, sockeye salmon, and Chinook salmon. Target locations were chosen by weighing information regarding current and historic salmonid use and contemporary discharge levels, and forecasts. This project was executed after an initial feasibility assessment exploring the use of video detection systems for enumerating fish passage at potential sites in the Okanogan basin (Nass and Bocking, 2005). Additional background information and history is provided in that document. This document presents the evolution and the current status of the operating protocols of the OBMEP video project.

## SAFETY

Data collection activities take place in streams and rivers at relatively isolated locations. The primary hazards associated with conducting underwater video operations in the Okanogan basin include:

- **Flowing water** (dynamic wading conditions) – use a wading belt and wading stick;
- **Uneven and slippery terrain** (falling while walking) – use proper footwear and walk cautiously;
- **Narrow walkways** adjacent to swift currents or deep water at Zosel Dam and Salmon Creek (falling while walking) - Wear harnesses (Photo 1) and attach to rope or railing during periods of stormy weather, icy conditions or flooding. Only carry as much gear as you can and still retain balance and footing.
- **Using power tools** (electrical shock and puncture injuries) – wear gloves and safety glasses and use tools according to manufacturer's labels.
- **Cleaning products** (inhalation of toxics or skin irritations) – wear gloves and do not inhale unsafe amounts of bleach or CLR.
- **Swift currents** during flood conditions (slipping, falling, being struck by objects) – large woody debris and boulders can be carried unseen by swift currents. Use a wading stick to check for hazards below the water's surface.
- **Tree and shrub branches** (poking or scratching eyes) – use safety glasses
- **Poison oak and ivy** (skin irritations) – be able to identify poisonous plants, carry skin wash;
- **Electricity** (electric shock) – use breakers where applicable, test leads with volt meter before connecting; and
- **Heavy objects** (lifting injuries) – use the "buddy system" and proper levers. Crews must work in pairs and carry a cell phone.
- **Driving** (vehicle accidents) – be focused and alert while driving to and from work sites. Arrive alive.


Photo 1: Video Technician wearing harness during ice-up at Zosel Dam video site

# EQUIPMENT

## *Digital Video Recorders*

Photo 2: Dedicated Micros (DM) Keyboard and DV-IP Server.

Photo 3: APC Power Conditioner.

In 2009 the OBMEP underwater video program switched from a Honeywell DVR removable hard drive cartridge system to a Dedicated Micros DV-IP (digital video-internet protocol) server. The IP feature allows video to be accessed and manipulated over a private network or over the internet by using the NetVu ObserVer software. The DV-IP server was chosen because of its ability to stream high definition footage, live in real-time across the internet, and the software's ability to catalog motion detected fish passage events. The previous Honeywell system stored the video on hard drive cartridges which had to be physically transported back to the office and reviewed. Tributary sites utilize TransVu DV-IP servers from Dedicated Micros.

At Zosel dam, an APC power conditioner and battery backup maintains a constant power supply to the DV-IP server, protects the server from power surges and other disturbances, and eliminates electromagnetic and radio frequency interference (EMI/RFI) as a source of audio-video signal degradation. To prevent any loss of recorded video footage, the DV-IP server should not be allowed to turn off or lose power for any length of time.

*DV-IP Sever Specifications*

For detailed specifications, go to www.dedicatedmicrosus.com/?id=114 and view the DV-IP server datasheet documentation.

- Dimensions: 3.5" × 17.3" × 17"
- Weight: 25.1 lbs
- Operating Temperature: 41° to 104° F
- Recording: MPEG-4 and, or JPEG @ QCIF, CIF, 2CIF; and 4 CIF
- Internal Capacity: 1 terabyte

*Manufacturer*

Dedicated Micros USA, 14434 Albemarle Point Place, Suite 100, Chantilly, VA 20151 USA. Servers were initially purchased through Goldline Marketing Int'l Inc. (phone # 888-815-3727), but it is possible to purchase directly from DM in the future.

*Servicing*

DM provides round-the-clock technical support over the phone at 1-877-DM-SUPRT.

*Software Upgrades*

DM provides upgrades on their website which can be downloaded for free and uploaded to the DV-IP server via USB flash drive. This should be done periodically but with caution to ensure the best function of the DV-IP server.

*Temperature*

The DV-IP server is rated to operate between 41° and 104° F. At Zosel dam in the winter, a 1500 watt space heater is placed in the enclosed cabinet that houses the server. When outside temperatures begin to drop below 50° F, the heater should run continuously with the thermostat set at 55° F. The server may malfunction if temperatures drop below the specified minimum operating temperature. If the server malfunctions, it should be turned off and back on via the switch on the back left corner. High summer temperatures have not caused the server to malfunction.

***Router***

Photos 4&5: Belkin Router.

A wireless internet router connects the DV-IP server to the internet so that the recorded video may be accessed remotely at any time. A Belkin wireless G router (model F5D7234-4) is currently used at Zosel dam and the tributaries.

***Antennae***

Photo 6: Wireless Internet Antenna.

Wireless internet antennae provide remote internet access at all of the sites. Antennae are mounted securely on power poles or high points or the roof structure at Zosel Dam. The antennae are owned and maintained by the Colville Tribe Fish and Wildlife. The internet provider may send a text message and/or e-mail to OBMEP staff if the antennae or wireless network lose functionality.

***Monitor***

Photo 7: Sony Trinitron Monitor.

A monitor is used at Zosel Dam to view the cameras real-time for maintenance purposes and to turn off the Zone Alarms during cleaning of the boxes.

***Cameras***


Photo 8: IAS underwater camera, camera bracket, cable and interface box.

The Colville Tribes use SeeMate Pro underwater cameras (Integrated Aqua Systems or IAS, North Vancouver, BC, Canada) with 2.9 mm wide angle lenses, mounting brackets with user-defined lengths of detachable, and polyurethane- jacketed cables suitable for underwater use. Although the cameras are available in black/white or color the Colville Tribes use color cameras to enhance image contrast. A waterproof camera interface box is used for powering each camera, and transferring the video signal from the underwater coaxial cable to the DV-IP server. The interface box has an input port to accept the camera cable, and a respective output port of RG-6 coaxial cable (plugs into the back of the server).

*Camera Specifications*

Detailed specifications can be found at www.iasproducts.com/C2-3SeeMateProC.html.

- Input Power 12V DC
- High impact Delrin 2-part housing with 6.5mm thick abrasion resistant Acrylite AR lens
- Pressure tested to 70m
- 2.9 mm wide angle lens with 9.1m depth of field

*Manufacturer*

IAS Products Ltd., 1415 Dominion Street, North Vancouver, B.C., Canada, V7J 1B3

*Servicing*

IAS provides technical support from 8:00am-5:00pm, Monday to Friday, 1-604-924-1844. Cameras require regular replacing of the O-ring gasket at the cable attachment and applying a di-electric grease to maintain the waterproof.

*Warranty*

Twelve (12) months from the date of shipment excluding damage due to accident, abuse, misuse, modification, misapplication, damage during shipment, or improper service or storage.

***Surveillance Cameras***

Surveillance Cameras (ARM Electronics Bullet Color Cameras from B&H Photo Video) are installed at each of the video sites to monitor for any potential equipment issues, site conditions or vandalism.

***Lights***

Photo 9: IAS SeeBrite LED light with cord.

In 2012, the underwater video program switched from fluorescent lights to LED lights to reduce frequency interference to the PIT tag arrays also installed in the Zosel fishways and tributary sites. The LED lights introduce 0-10% noise levels to the PIT arrays and the fluorescent lights introduce 30-70% noise. Acceptable noise levels for PIT tag detections is anything less than 20%. In addition, the LED lights produce a clearer, more colorful image of the fish species which helps in identification. Also, the LED lights do not have to be replaced as often because their life expectancy is 11.5 years compared to 2 years for fluorescent lights. At Zosel Dam, one 4-panel LED light is placed along the top or bottom edge of the viewing window. At the tributary sites, one single-panel LED light is placed vertically at the left or right edge of the viewing window (Figure 1).

*LED Light Specifications*

Detailed specifications can be found at www.iasproducts.com/LEDLight.html.

- LED operating life 70,000-100,000 hours – up to 11.5 years operating 24 hr/7 d
- Variable bulb length (17” for tributary sites 30” for Zosel Dam)
- Sealed and inspected underwater power cable connection to housing
- Polyurethane jacketed cable for continuous in-water use
- Input Power 120V AC, 50-60 Hz
- Lexan molecular bonded hard coat external tubular enclosure filled with Dow® silicone transformer oil to control overheating
- polyurethane-jacketed cable

*Manufacturer*

IAS Products Ltd., 1415 Dominion Street, North Vancouver, B.C., Canada, V7J 1B3

*Servicing*

Technical support available from 8:00am-5:00pm, Monday to Friday, 1-604-924-1844.

*Warranty*

2 Year Warranty. LED lights MUST be operated only when submerged in water.

***Fish Guidance Structures (FGS)***

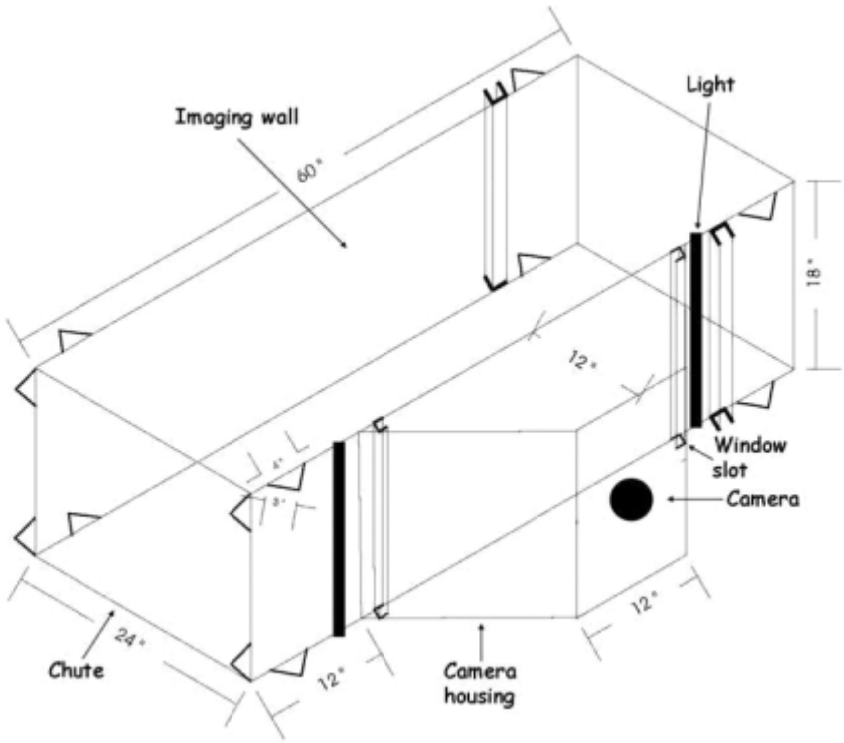


Figure 1. Tributary Video chute – Three dimensional line view.

The design of a video chute varies by site characteristics, but the basic layout of the chute is the same (Figure 1). Fish pass through a rectangular migration chute, to which the camera housing is attached along the side. The camera housing and the migration chute are separated by a pane of glass which provides for a minimum distance between the camera and target in the field-of-view (FOV). The pane can be removed for cleaning, or for access to the interior of the camera housing.

Placement of the chute in-stream depends on the specific characteristics of the site, but the orientation is usually parallel with water flow to minimize water turbulence and air entrainment in the chute. Air entrainment causes motion detection triggers in the video system, filling up the limited DV-IP server hard drive storage with false fish passage events.

At the tributary sites, the video chute frames have picket weirs to guide migrating fish through the video chute (Photo 10).


Photo 10: Standard video installation on a small stream.

The pre-existing upstream fish passage structures (i.e., fishways or fish ladders) were used as the fish guidance structures at Zosel Dam to move fish through the video chambers (Photo 11).

Photo 11: Custom video chute installation at Zosel Dam, left bank.

The use of multiple chutes to partition the water column into adequate fields-of-view for the cameras is illustrated in Photo 12.

Photo 12: Custom video chute for Zosel Dam, left bank.

*Fish Guidance Structure Specifications*

Chute and camera housing are constructed of aluminum tubing and plate and covered with ultra-high molecular weight (UHMW) plastic; the chute with white and the camera housing with black. Actual dimensions should be considered with respect to anticipated water clarity/turbidity. Reduced water clarity (higher turbidity) requires target objects in the field-of-view (FOV) to be closer to the camera. This can be achieved by narrowing the width of the chute, or moving the camera closer to the chute. Moving the camera closer will decrease the FOV.

*Manufacturer / Service*

Diebel's Welding & Machine Shop in Omak, Washington has been the primary builder of the video chutes and has performed most of the maintenance and modifications to the chutes.

### *Maintenance Tools and Supplies*

- GB Gardner Bender - Cable & Electrical Multi-Tool Stripper/Crimper/Cutter
- Rivet gun & rivets
- Aluminum flat panels, square tubing and 90 degree angle tubing
- UHMW Plastic panels
- O rings for cameras
- Extra windows in case glass breaks
- Back up DV-IP server

***Power***

As of 2013, underwater video tributary sites all have power poles on-site and the Zosel Dam facility provides electricity to the video system there. Extension cords are used to run power to the electronics enclosures.

## SITE SELECTION

Selecting appropriate sites for placement of a video system requires assessment of the many factors that might influence and affect the collection of usable imagery. OBMEP primarily focuses on the downstream extent of specific fish population segments as

outlined in the Upper Columbia Monitoring Strategy (Hillman 2004). However a number of other considerations were taken into account, including:

- locations of current and/or historic runs of summer steelhead;
- suitable channel morphology and hydraulic conditions for installation and operation of a video chute and fish guidance structure – channel characteristics and discharge need to be conducive to using the previously tested in-stream components;
- suitable water clarity during the monitoring period – low turbidity and debris characteristics are preferred;
- suitable access for chute installation, monitoring and maintenance – relatively easy access for people and equipment, and permission from land-owners, and
- access to electricity for powering the system – existing AC power is preferred, although it is possible to operate these systems using DC battery arrays.

Nass and Bocking (2005) assessed the feasibility of using video systems at six potential mainstem sites along the Okanogan River and nine potential sites on tributaries using the above listed characteristics. Zosel dam was selected as the mainstem site because it provided an established fish guidance structure. The site is located at the downstream extent of an important population segment (fish entering Canada). Water clarity is good, flows relatively consistent and electrical power already existed. However, for tributary locations it was necessary to conduct additional field investigations. The Colville Tribes' geographic knowledge of active salmon/steelhead production areas suggested the development of video counting stations at tributary locations: Ninemile, Tonasket, Bonaparte, Antoine and Salmon creeks.

## INSTALLATION – DIGITAL VIDEO SYSTEM

The installation procedures for an underwater video system depend mostly on the physical characteristics of the site and the location of power. As discussed in the SITE SELECTION section of this document, several key characteristics determine site suitability for video application. Once a site has been determined as appropriate with respect to basic capacity and function criteria, additional details need to be documented in order to develop a site specific design. Therefore, every installation begins with an initial site visit to conduct a general survey for documenting any special needs. Researchers will measure wetted and bank-full channel width, conduct a simplified cross-section survey, record bank and channel substrate type, and take multiple photos. This information will assist in designating a preferred location and orientation for the video chute and electronics enclosure (DV-IP server housing). These data will also assist in developing a materials list for the installation, including the anticipated number of video chutes, weir panels, in-stream anchors, sand-bags, and bank covering.

### *System Layout*

A typical video system includes:

- Video chute;
- Camera(s) and respective cable;
- Underwater lights and respective cable;
- Electronics enclosure box;
- DV-IP server;
- Router;
- Antennae;
- Power supply and respective cable;
- Weir panels or other guidance structure;
- Surveillance camera

The general layout of a stream-based installation is presented in Figure 2. Camera and light cables should be lashed to the chute and other in-stream structures to prevent wear and tangling. Cabling is run from the video chute to the electronics enclosure along the most secure and direct route. Plastic electrical ties can be used to affix the cable to solid structures. The camera(s) are pointed directly toward the opposite wall ("the back wall") of the video chute, and the lights directed toward the approximate center of the back wall.

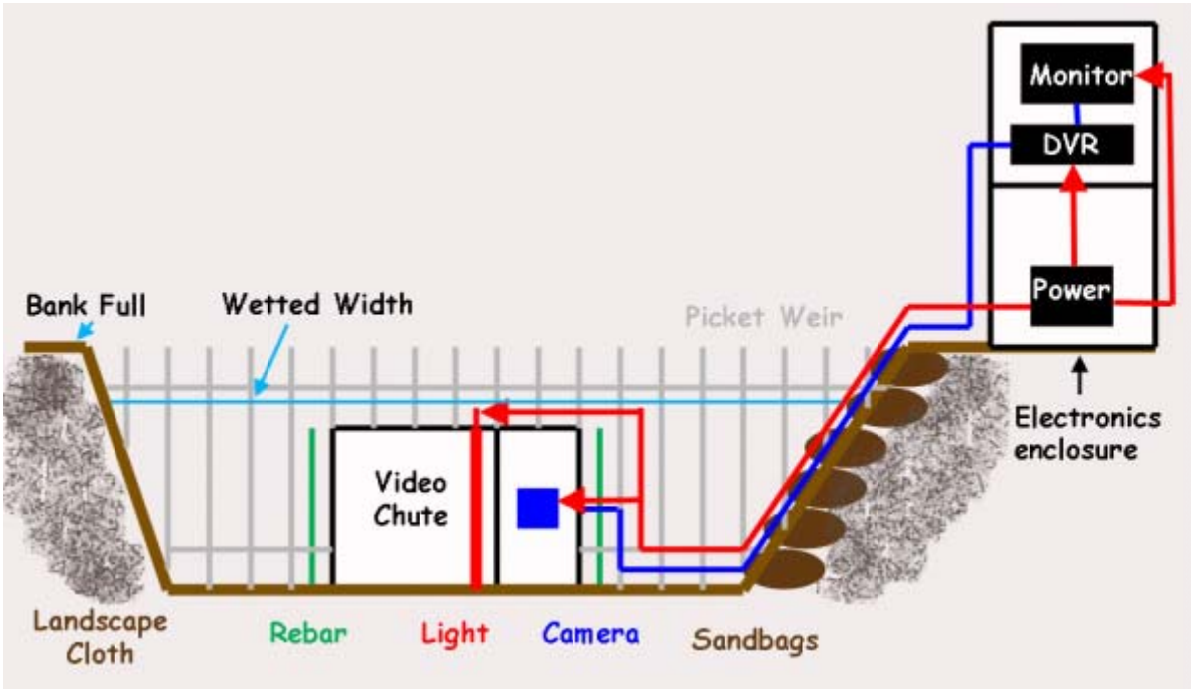


Figure 2. General layout of an underwater video system.

*Site Preparation*

Data collection typically occurs over a range of water flows and elevations. Therefore, impacts of the video chute installation on the stream channel in terms of erosion need to

be anticipated. Sandbags can be used to stabilize the substrate in the vicinity of the chute, and landscaping cloth can be used to stabilize the banks. These materials should be installed upstream and downstream of the structure to the extent that potential water conditions dictate. Stakes (wood or plastic tent style), landscaping staples (4" U-shape), and T-posts (metal fencing rods) may also be used to secure protective materials. The site can then be restored to its original condition after monitoring has ceased by removing all installed materials. Grass seed covered with straw can be used for the final covering of exposed areas.

### *Power*

The electronic components of a video system require electricity to operate. The DV-IP server and lights use 120v AC power, and the cameras use 12v DC power. If AC power is available at a site, all components can be run off an outlet strip with the DC powered components interfacing through a Class II transformer. If only DC (battery power) is available, a DC-to-AC inverter (minimum 400 watt, application dependent) will be required to power the AC based components. A typical video system uses approximately 5000 watts of energy per 24 hours at 120v and 2 A. This consumption rate is easily met using an AC power supply but requires substantial infrastructure for a DC power supply. For example, a typical video system will use all the energy in 6 deep-cycle batteries in just over 24 hours. Therefore, in this case, the batteries would need to be swapped out or recharged (e.g., solar or generator) on a daily basis. Power poles have been installed at all three tributary sites to provide an AC power source for all video monitoring equipment. The Zosel Dam facility provides AC power to the underwater video equipment at that location.

### *Video Chute*

The important aspect of the video chute with respect to installation includes the need to anchor the chute in the stream channel. Rebar is most easily used for this purpose by pounding the rebar into the stream bed through the anchor guides on the chute. The stream channel may require some minimal redistribution to properly seat the chute to the stream bed. The chute should be placed directly into the main flow of water, oriented in a way that does not restrict fish passage through the structure, while also minimizing the amount of turbulence and air entrainment inside the chute. Note that turbulence causes a reduction in the quality of imagery. The chute should also be securely anchored to a large tree or firmly secured pole by rope, chain or cable to help prevent loss during an unexpected scour event.

### *Picket Weir*

In most cases, the width of the video chute will be much less than the anticipated wetted width of the stream channel. Therefore, a fish guidance structure, in the form of a picket weir, may be used to force fish to pass through the video chute and eliminate passage around the structure. Weir panels typically are comprised of a metal frame with holes

sized to accept pickets (typically aluminum or PVC), and then tied into the chute and stream bank. Depending on the anticipated water conditions, pickets may be installed perpendicular to the flow (vertically straight up and down, see Photo 5) or in a downstream slanted orientation (e.g., 45 degrees off the horizontal). The pickets allow water and most debris to pass downstream while preventing fish from getting around the video chute.

### *Testing the Video System*

After the in-stream structures have been secured and the electronic components arranged in the enclosure, the system is powered up to begin optimizing the array. The user must orient the camera(s) and lights, and ensure data collection is occurring. Ambient lighting, water turbidity, and water turbulence are the primary factors that will determine the relative quality of the collected imagery. The ability to connect a laptop computer to the DV-IP server at the video monitoring location allows the set up crew to ensure the system is up and running and that the cameras are oriented in the proper configuration.

## SAMPLING DURATION

Operational timing and sampling duration is dependent upon the target species and location being studied.

### *Mainstem Okanogan*

In 2012, video imagery was collected at Zosel Dam all day, every day of the year. This site provides the only real-time fish movement data in the basin, and therefore is a useful tool for developing baseline data for multiple fish species. Special seasonal periods of interest include March through May for anadromous adult steelhead, and July through November for adult Chinook and sockeye.

Zosel Dam is owned by the Department of Ecology and operated by the Oroville-Tonasket Irrigation District (OTID). The OTID adjusts the levels of the four spillway gates of the dam according to the International Joint Commission, which mandates the maintenance of Lake Osoyoos between 909 and 913 ft. elevation. The spring freshet in the Okanogan River occurs between April and June but can occasionally run until August. In order to maintain the lake level, the OTID may open the dam gates high enough for fish to pass through the gates rather than through the fish ladders and video boxes. The tail end of the steelhead run and the beginning of the sockeye run may be affected by missing those fish that travel through the gates. The dam gate levels must be monitored to keep the validity of the data collection in perspective. For example, in 2011 and 2012, high snow pack and high spring rainfall caused the lake levels to be unusually high, and the bulk of the sockeye run passed through the gates without being detected in the video arrays.

*Tributaries*

The primary focus of tributary monitoring is to document movements of anadromous adult steelhead during the period March through June. Video boxes are installed in late February prior to the start of the run which generally begins mid-March. Removal of the video boxes was pushed out to July and August in 2011 due to high flows and swift currents. Fish passage events can easily be missed during these high flow periods due to turbidity and debris obscuring images and the opportunity for fish to pass over the top of the box and weir given enough flow.

## PERMITTING

Installation of an underwater video system requires obtaining a Shoreline Exemption from Local Government and an HPA (Hydraulic Project Approval) from WDFW because components are installed directly within the high water mark of streams. These permits are obtained by submitting a JARPA (Joint Aquatic Resources Permit Application Form) to Local Government (county or city Planning Departments) for the respective streams. Local Government then forwards the application on to the appropriate agencies for consideration. For video applications conducted by the Colville Tribes, the activities are also carried out under NOAA Fisheries Permit #1412 - Direct Take authorization, according to Section B, Conditions 16 and 22. HPA permits for Salmon, Antoine, and Ninemile Creeks are valid from Feb. 21,2009 through Feb. 21, 2014. An HPA permit for Zosel Dam is not required because the video monitoring system is installed within the dam structure where the river is considered an un-natural waterway.

## VIDEO STATION OPERATIONS

The underwater video system described in this manual is designed to operate all day, every day of the year with minimal down-time. Of course, this depends substantially on the environmental conditions where the imagery is collected and the degree to which the system is maintained. Efficient data collection will minimize the amount of imagery collected and thus reduce the time required to analyze the imagery. To this end, a video station must be visited regularly to assess the functionality (operational performance) and conditional integrity (i.e. structural damage) of each component. Consider the following unusual circumstances prior to damage occurring:

- Ice flows caused by extreme or prolonged freezing temperatures have caused the video box window glass to break. Make sure there are back up windows available. Consider having plexi-glass back up windows to use during ice up events.
- High flows have caused large debris to rest on top of Zosel Dam video boxes, which required concerted effort to remove. Be aware of any potential large debris in the vicinity of the boxes that may shift during high flows. Prevent them from coming into contact with the video boxes prior to them becoming a problem.
- Milfoil and other aquatic plants become attached to the video boxes and trigger

zone alarms. The constant zone alarms use up storage capacity in the DV-IP server memory. Until a strategy to reduce the amount of milfoil in the boxes is developed, the boxes must be cleaned every other day.

- Low temperatures have caused the DV-IP server to crash. Make sure the electronics enclosures are protected from extreme temperatures.
- Rodents have chewed through surveillance camera cables. Check cables often.
- Flood control sand bags have washed into video boxes and gotten trapped there during high flows. Secure objects on banks prior to high flow events.
- When debris and sediment decrease image quality (obscuring the FOV) and collection efficiency (triggering motion detection events) the image collection settings can be adjusted from the office, if required.

Photo 13: Milfoil and other aquatic plants lodged in video chute.

*Zosel Dam Cleaning Procedures*

- Unlock electronics enclosure shed and turn on TV monitor. Disable Zone Alarms for all cameras.
- Unlock supply containment boxes, gather cleaning supplies and hand drill with bits and adapters for opening camera box door.
- Plug in power supply for crane. Check cable on the crane spool for frays and proper alignment.
- Raise video box out of water making sure it doesn't bind up on the slide mount, and make sure that there is no tension on the camera and light cords.
- Go to plywood box & get cleaning utensils. Open tool box and get drill box.
- Remove debris and milfoil from fish passage chutes and camera box.
- Remove algae and macrophytic organisms from all surfaces by scrubbing fish passage chutes, lights, windows, cameras, cords and camera box. Tools required for this job are long handled scrub brooms, hand scrub brushes, Scott heavy duty rags and bleach and CLR cleaning solvent in separate spray bottles.
- First clean all surfaces with CLR, second spray surfaces with bleach. Finishing with bleach impedes macrophyte growth.

- Lower the video box back into the water.
- Tie off camera & light cables with rope to the guard rail when finished.
- Unplug power cord to the crane and place a 5 gallon bucket over the electrical components of the crane.
- Put all cleaning supplies and drill back into containment boxes.
- Turn the video Zone Alarms back on.
- Check router to make sure it is running (green light). Turn off the TV monitor. Check heater to ensure proper function (during the months when outside temperature falls below 50 degrees F). Close & lock the door of the electronics enclosure box.

## IMAGE ANALYSIS

Imagery collected by the DV-IP server is reviewed by technicians on a PC or laptop workstation in the office. The workstation is comprised of a PC or laptop with the current version of NetVu Observer installed, paper datasheets, and an electronic database. The NetVu Observer software provides an efficient utility to review the imagery and archive imagery when desired. The process begins with opening the NetVu Observer software, waiting for the software to connect to the DV-IP server, and selecting the desired IP address (i.e. Zosel Dam or a tributary). Fish passage events are listed in sequential order in which they occurred and technicians can filter the events for the desired date of review. After video review is complete, the data can be recorded in the electronic database. All salmonid and non-salmonid fish species are recorded at this time but non-salmonids can be dropped if budgetary and time constraints reduce technician availability for this task.

*DV-IP Server*

Remote communication with the DV-IP server via a wireless internet connection provides real-time access to the DV-IP server and the imagery. Remote access is an important tool for determining if or when servicing is needed at the station. Motion detection imagery is collected on an “event” basis. An event in this context is the movement of a fish past a camera. The DV-IP server has the ability to detect changes in the value of pixels (as related to light or dark shades), or groups of pixels, with a specified change in shade contrast resulting in logging of a potential fish passage event.

After initial installation, the DV-IP server will not require additional procedures to operate, other than occasional software/firmware upgrades. Software upgrades should be performed only if the unit is not operating as expected or if the manufacturer recommends it for continued use. Software upgrades can be downloaded off the Dedicated Micros website and installed via USB drive. Upgrades require technical advice from Dedicated Micros and can cause loss of stored video, so be prepared when attempting this procedure.

Additional details and the latest software updates can be found under the “Support” link

at www.dedicatedmicrosus.com/ by clicking on “Manuals and Guides” and downloading the “Dedicated Micros DV-IP Server Installation & Operations Guide” or by clicking on “Software Downloads.”

*NetVu Observer Procedures*

NetVu Observer software is used in conjunction with the DV-IP server and internet connection to allow an operator to monitor and configure video from image servers from one or several sites. The external IP-addresses for Zosel Dam is 64.139.106.91, and the tributary sites are assigned new IP-addresses each season.

- Start-up
  -Start NetVu Observer – Click on desired video location - opens with live view;
  -Use PAUSE, FORWARD; REVERSE, etc. buttons to view recorded imagery;
  -Switch between live and recorded as desired using the buttons;
  -Use GoTo box to view a specific date/time of recorded imagery;

- Viewing Events
  -Click “Show/Hide Events Tab” button (looks like a small sheet of paper below the GoTo box);
  -Change screen to single;
  -Adjust image size by dragging vertical partition line;

- Filtering for certain dates/times/cameras
  -Click “Show/Hide Events Tab” to show events;
  -Click “Filtering” button on right of partition;
  -Select start/end date/times, and cameras as desired (e.g. Start: May 7 00:00:00, End: May 7 23:59:59), and then click apply;
  -Watch out that the event list is presented in AM/PM format while the date selection tool is in 24 time format;
  -Event List starts with earliest record in query;
  -Arrow keys move up/down list, or use the mouse;
  -Next/previous page to shuffle;
  -Use play-back directional buttons to view desired period, use fast forward/rewind settings to speed up and slow down video play-back.

*Save Video Instructions*

1. In NetVu Observer, click on the download video button (looks like a cylinder with an arrow pointing down located below the date/time ticker).
   -“Select Download Type” – click “Filtered Download”
   -“Select time period to download” - select start and end time.
   -“Save file as” - click browse and choose desired folder where you want to save clip with a temporary name.
   -Select camera

-Unclick “Pause video during download”
-Click “Start download”
-Wait till “Download complete” appears.
-Close the download screen

2. In NetVu Observer, go to File and Open Video
-In Files and folders to import, click Add
-Locate the the .par clip you saved and click open
-Click on the .par clip again so it is highlighted and click OK.
-After the Progress Message is displayed, click Done.
-Let the file play and make sure it has the desired start and end time.
-Go to File→ Export
-“Select time period to export” - adjust start and end time if desired.
-“Select cameras to export” – select the correct camera
-“Export files to” - Make sure you will export the file to the desired folder. Click Browse if you need to change the folder.
-Click on “Begin Export” – after the Progress is 100%, close the Export screen and click “Close Video.”
-Browse to the folder you saved your clip in, open clip to make sure it exported properly. The video file was automatically named, check that the date and time are correct and add species information to the end of the name.
-Delete .par file.

*Save Still Shot Instructions*

-Pause video with desired frame
-Right click on image
-Click Save and navigate to desired folder
-Save file name as site-camera-dateyyyyddmm-timehhmmss-species (e.g. Zosel-4-2012301-040521-omykiss). NetVu will automatically name your photo in this format but you must check to make sure the date and time are correct because the program is often wrong.

*Zone Alarms*

Zone Alarms are movements across a zone (section of the field of view) that detect an alarm of motion, and result in a saved event. The alarm settings are adjusted by accessing the Dedicated Micros NetVu Observer Configuration Page via the browser (for Zosel at http://63.142.202.27/gui/gui_outer_frame.shtml ), clicking on Configuration, then Alarm, then VMD, and then adjusting both the shape and pixel count of Zones 1 and 2 for each camera. The pixel count should be left at 5% and the zone shape should remain constant but occasionally debris and/or air entrainment triggering motion detection events requires the pixel count to be set at 10% or 20% and the zone shape to be reduced to eliminate the debris. Zone Alarms are also turned off during cleaning and maintenance of the video boxes to reduce triggering events and the resulting usage of DV-IP server memory storage.

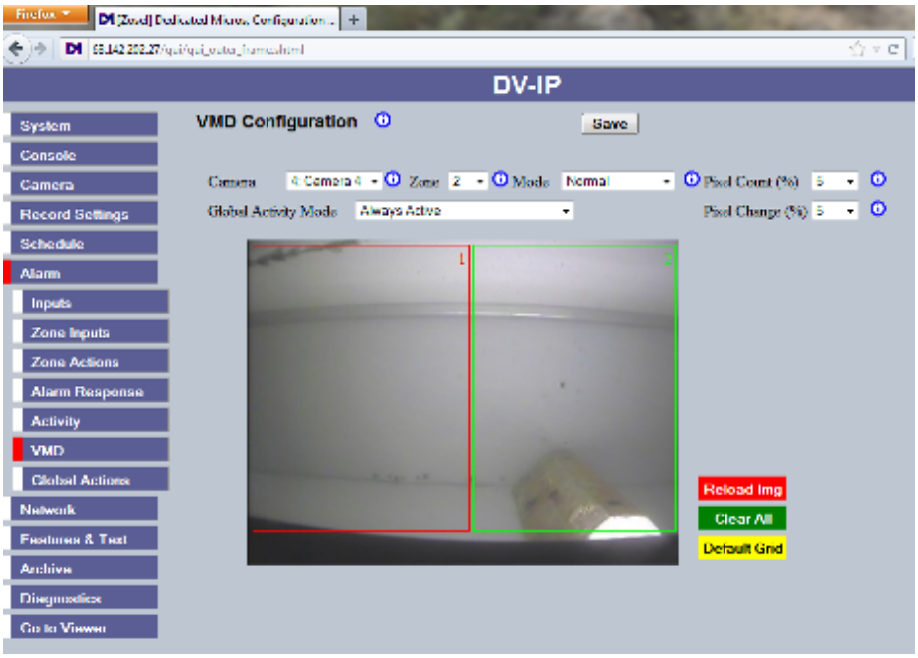


Figure 3: Zone Alarm (VMD) Configuration Page

*Weeds, Macrophytes and Air Bubbles*

When aquatic weeds, macrophytic organisms and air entrainment cause constant zone alarms, the video system does not differentiate between those alarm events and a fish passage alarm event. A user watching these individual events saved by the DV-IP server will miss some fish passage due to the constant motion overloading the zone alarms. Watching the video streaming instead of event by event is necessary in these cases. A user can run the recorded video at a rate much higher than normal playback and still detect most fish images. However, playing the clips back at too high of a rate is discouraged as this results in potential missed fish passage events. Viewing at 4X normal speed will provide the best viewing without missing fish passage events.

*Passage events*

A fish passage event is documented when a fish enters into the FOV from one side and exits the FOV from the opposite side. The event is recorded immediately after the fish has exited the FOV. Even if the same fish returns back into the FOV a split second later, the initial passage is recorded as an event. One single fish may have an unlimited amount of passages up or down, as long as it completely exits the FOV each time. Do not record a passage if the fish does not completely exit the FOV. Do not record an event where a fish enters the FOV and turns around within the FOV and exits the same way it entered UNLESS: an uncommon species (i.e. Bull Trout or Chinook) or event occurs in areas or timings not normally encountered.

Anadromous species info collected: camera, hour, species, male or female, direction, marked/unmarked, life stage (adult or juvenile), quantity, (exact time is also required if verification is needed and a video clip/still shot is not taken).

Resident species info collected: camera, hour, species, direction, and quantity. If recording a sizeable anadromous run such as sockeye, limit resident data collected to: species and quantity for the day, eliminating hour and direction data to save time. Do not collect or enter into the database life stage data for resident fish.

### *Fish Identification*

The quality of imagery obtained from a monitoring site varies according to specific site conditions including water flow, turbidity, and turbulence. Therefore, the ability of the reviewing technician to accurately identify a fish to species will also vary. However, using a variety of key indicators including size, morphometry, color, and swimming pattern, a fish can usually be accurately identified to species. Other considerations such as general life history (where and when they spend portions of their life) and timing (e.g., month) of imagery collection, can be used to validate classifications. When the imagery is unsuitable for confident species identification (i.e., steelhead, rainbow trout, sockeye salmon, Chinook salmon), the fish is recorded by family (unknown Salmonidae), or as unknown (e.g., cannot discern if the fish in the image was from the family Salmonidae or any other identifiable fish).

Several sources of information are used in the identification process including descriptions and photos in books (e.g., Wydoski and Whitney, 2003, morphometric structures Figure 4), photos collected in the field, previously collected and archived imagery, and pattern recognition through imagery interpretation experience. Examples of species-specific imagery collected at Zosel Dam and Salmon Creek are presented below, along with an outline of general specification characteristics for classifying fish observed in the imagery.

After much discussion, a standard way of documenting *Oncorhynchus mykiss,* which include anadromous steelhead and resident rainbow trout, was decided on. If the fish is a juvenile, record the species as *Oncorhynchus mykiss (O. mykiss)*, because it is unknown whether the fish will become anadromous at this point, also record camera, hour, juvenile, direction, marked/unmarked, and quantity. Record adult rainbow trout as Rainbow, also record camera, hour, adult, direction, marked/unmarked, and quantity. Record adult steelhead as STLHD, also record camera, hour, adult, direction, marked/unmarked and quantity; exact time is also required. Save a video clip or still-shot of all steelhead passage events.

Video reviewers may observe imagery of one or more of the following fish species at various life stages (juveniles, adults, jacks): steelhead, rainbow trout, Chinook salmon, sockeye salmon, common carp, bridgelip sucker, largescale sucker, northern pikeminnow, mountain whitefish, brown bullhead, yellow perch, smallmouth bass, largemouth bass, bluegill, chiselmouth, peamouth, crappie, tench, and redside shiner.

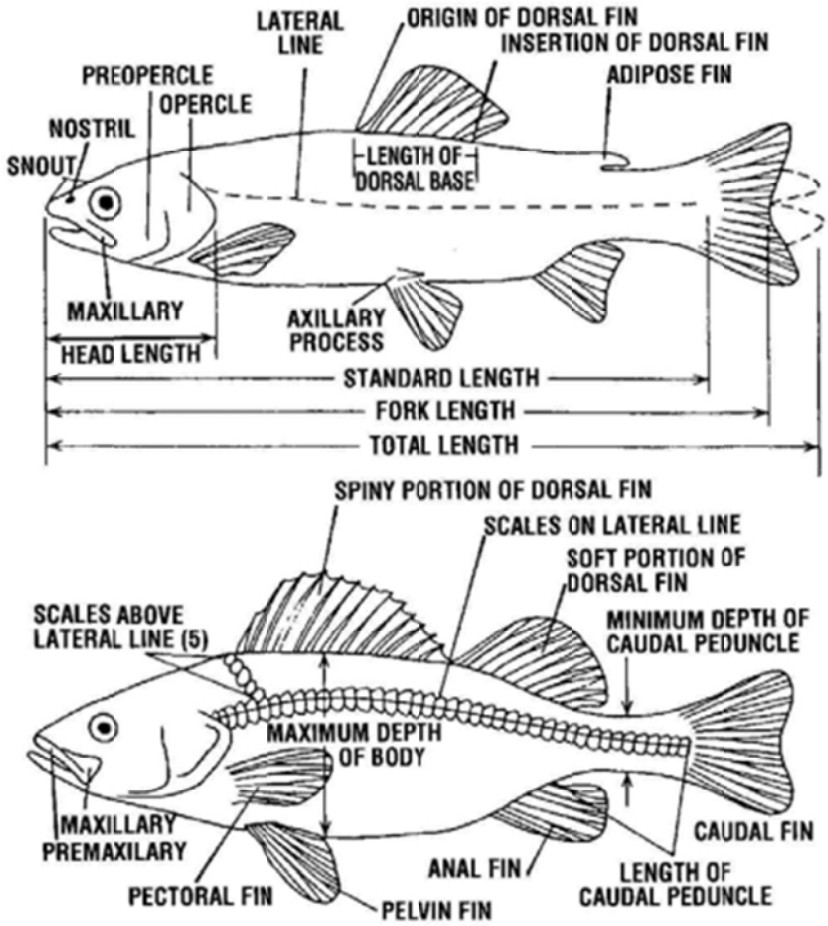


Figure 4: External structures and measures of fish (reprinted from Wydoski and Whitney, 2003 with permission).

*Adult Summer Steelhead*

**Size**: Medium to large (40-60 cm)
**Morphology**: Large mouth with hooks on lower jaw (male), smaller mouth and more rounded snout (female), ventral fins have white tips, mostly squared caudal fin with minor fork.
**Color**: In the Okanogan, usually significant pink coloration on mid to lower operculum, and along the lateral line and abdomen between the ventral and anal fins; prominent black spots predominately above the lateral line, including the dorsal fin and caudal fin. Occasionally silver bright.
**Swimming Style**: Slow but steady upstream movement, effortless looking tail beats, bottom orientated.
**Marks**: Adipose clips are common.


Photo 14: Adult female Steelhead passing upstream in Salmon Creek chute 2


Photo 15: Adult male Steelhead passing upstream in Salmon Creek chute 1

*Adult Chinook Salmon*

**Size**: large (50-90 cm)
**Morphology**: females elongated oval, males oval, anal fin longer than deep. Caudal fin slightly forked, ventral fins solid dark color, lower Jaw is light gray to black.
**Color**: In the Okanogan, dark tones of grey, brown, and red. Black spotting over most of the body and fins. May have dark colored circular marks from lamprey parasitism.
**Swimming Style**: Slow but steady upstream movement, effortless looking tail beats,

bottom orientated.
**Marks**: Adipose Clips are common. Jacks (small 30-50cm, sexually mature males) are common.


Photo 16: Adult male Chinook passing upstream in Zosel Dam chute 5


Photo 17: Adult female Chinook passing upstream in Zosel Dam chute 4

*Sockeye*

**Size**: Small to medium (30-50 cm)

**Morphology**: Females elongated oval, males deeply oval, sometimes with a significant dorsal hump. Relatively big eye for size of fish.
**Color**: In the Okanogan, bright to dark red body with greenish-brown head and caudal fin. Lack distinct spots in their back and caudal fin,
**Swimming Style**: Relatively rapid tail beats for movement. Typically observed in mid to lower chute.
**Marks**: Adipose clips are rare.


Photo 18: Adult sockeye passing upstream in Zosel Dam chute 4


Photo 19: Adult sockeye passing upstream in Zosel Dam chute 5

*Coho*

**Size**: Medium to large (40-70 cm)
**Morphology**: females and males elongated oval, first three anal rays much longer than other rays, giving fin a sickle-shaped appearance. Males with a pronounced hooked snout.
**Color**: In the Okanogan, dark red and green with an iridescent sheen. Black spots on back and only on the upper lobe of the caudal fin. Broad caudal peduncle. White gums in lower jaw.
**Swimming Style**: Slow but steady upstream movement, swift tail beats, bottom orientated.
**Marks**: Adipose Clips are uncommon.


Photo 20: Adult Coho passing upstream in Zosel Dam chute 4

## DATA ENTRY AND ANALYSIS

Salmonid passage events are recorded onto a datasheet (Figure 5) as they occur during imagery review. Passage events are tallied by day, hour and camera, and subsequently entered into a Microsoft Access database (Figure 6). Each hour for which there is at least one salmonid passage event is entered as a record in the database and specifies information about the event(s) including:

- Location (e.g. Zosel Dam);
- Date and Hour (e.g., dd-mmm-yy, 23:00); exact time (e.g. 23:00:01) of passage for steelhead is also helpful if a still shot or video clip is not taken
- Camera (e.g., #4)
- Species (e.g., steelhead, Chinook, sockeye, rainbow)
- Direction of passage (e.g., upstream or downstream). Note that for Zosel Dam

upstream movement is from left to right on the left bank array, and right to left on the right bank array; and for Salmon Creek, upstream movement is from left to right in box 1 and from right to left in box 2

- External markings, if present (e.g., unmarked, adipose clip)
- Number of fish (e.g., “10”, for the respective record-specific information
- Notes (e.g., “requires QA/QC review for confirmation of species”)
- Reviewer (name of person who entered the data)
- Review date (the date on which the data was entered, dd-mmm-yy)
- QA/QC reviewer (name of person who confirmed the observation)
- QA/QC review date (the date QA/QC was conducted, dd-mmm-yy)

| Location: Zosel | Reviewer: | QAQC Video Reviewer: | DB Entered by: | QAQC Database Reviewer: |
|---|---|---|---|---|
| | Date Reviewed: | Date Video QAQC: | Date Entered: | Date Database QAQC: |

| | Camera 2 | | Camera 3 | | Camera 4 | | Camera 5 | | Camera 6 | | Camera 7 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hour | up | down | up | down | up | down | up | down | up | down | up | down | CHM: |
| | | | | | | | | | | | | | MWF: |
| | | | | | | | | | | | | | LMB: |
| | | | | | | | | | | | | | BLS: |
| | | | | | | | | | | | | | NPM: |
| | | | | | | | | | | | | | SMB: |
| | | | | | | | | | | | | | PM: |
| | | | | | | | | | | | | | CARP: |

Figure 5: Example datasheet for recording fish observations.

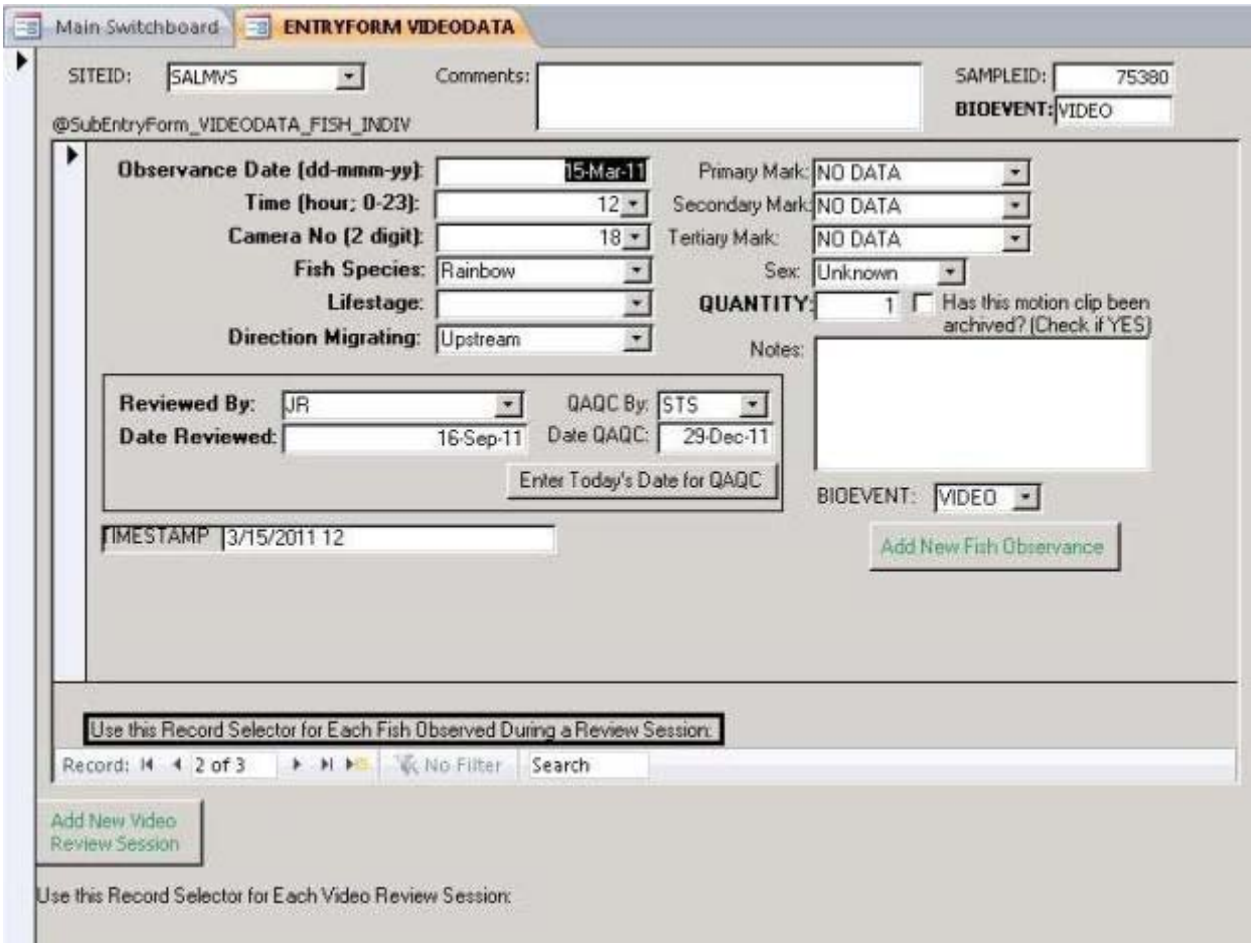


Figure 6: Access Database video data entry screen.

Details on the structure and use of the database are presented in Summit Environmental's OBMEP database user's manual (accessible at www.cctobmep.com/obmep_publications.php). Automated queries of the data are conducted using the Access database and include site and species specific summaries of counts by hour, day, and month.

## LITERATURE CITED

Dedicated Micros. 2012. Product Literature (User Manuals). www.dedicatedmicrosus.com/

Hillman, T.W. 2004. Monitoring Strategy for the Upper Columbia Basin. Draft Report. 107 p.

Integrated Aqua Systems. 2012. Product specifications. www.iasproducts.com/aProducts.html

Nass, B.L. and R.C. Bocking. 2005. The feasibility of using video detection systems in the Okanogan River Basin to enumerate adult salmon. Report prepared by LGL Limited, Ellensburg, WA for Colville Confederated Tribes, Nespelem, WA.

Summit Environmental Consultants Ltd. Okanogan Basin Monitoring and Evaluation Project (OBMEP) Database User's Manual. Project 652-01.07. August 2007.

Wydoski, R.S. and R.L. Whitney. 2003. Inland fishes of Washington. University of Washington Press.