

**Bonneville Power Administration  
Fish and Wildlife Program FY99 Proposal**

**Section 1. General administrative information**

**Etiology Of Headburns In Returning Adult Salmonids**

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**Bonneville project number, if an ongoing project**    9030

**Business name of agency, institution or organization requesting funding**  
AquaTechnics

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**Business acronym (if appropriate)**    AQT

**Proposal contact person or principal investigator:**

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**Subcontractors.**

<b>Organization</b>	<b>Mailing Address</b>	<b>City, ST Zip</b>	<b>Contact Name</b>
Texas A & M University	Dept. Veterinary Pathology, College of Veterinary Medicine	College Station, TX 77843-4463	Dr. Paul Frelier
Oregon State University	College of Veterinary Medicine, Oregon State University, Magruder Halll	Corvallis, OR 97331-4802	Dr. Barbara Watrous

**NPPC Program Measure Number(s) which this project addresses.**

4.1, 4.2, 4.3, 5.6E1, 6.1, 6.1A, 6.1B4, 6.1B7, 6.1B.8

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**NMFS Biological Opinion Number(s) which this project addresses.**

NMFS: Conservation Recommendation #2: Adult Studies/Adult Passage; Reasonable and Prudent Alternatives: (8) Fallback, (16) Total Dissolved Gas.

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**Other planning document references.**

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**Subbasin.**

Primarily Snake River subbasin

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**Short description.**

Define the nature and cause of head injuries in adult returning salmonids that appear to result in prespawning mortalities. Characterize and evaluate “headburns” and their etiology to validate monitoring and provide a basis for prevention strategies.

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**Section 2. Key words**

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
X	Anadromous fish		Construction		Watershed
	Resident fish		O & M		Biodiversity/genetics
	Wildlife		Production		Population dynamics
	Oceans/estuaries		Research		Ecosystems
	Climate		Monitoring/eval.		Flow/survival
	Other	X	Resource mgmt	X	Fish disease
			Planning/admin.		Supplementation
			Enforcement		Wildlife habitat en-
			Acquisitions		hancement/restoration

**Other keywords.**

Prespawning mortality, adult survival, head injuries, head burn, scalping, fallback

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**Section 3. Relationships to other Bonneville projects**

Project #	Project title/description	Nature of relationship
	Not applicable	

## Section 4. Objectives, tasks and schedules

### *Objectives and tasks*

<b>Obj 1,2,3</b>	<b>Objective</b>	<b>Task a,b,c</b>	<b>Task</b>
1	Physiological and pathological characterization of headburns	b	Necropsy of fish at Lower Granite Dam fish holding facility
1		e	Histological and radiographic evaluation of injuries
1		f	Evaluation of infectious agents in lesions
2	Exacerbation of headburns in adult holding facility	a	Lesion characterization and observation at Lower Granite facility
3	Frequency and timecourse of healing lesions	a	Lesion characterization and observation at Lower Granite facility
3		c	Characterization of injured fish moved to Oregon and Idaho facilities
4	Outcome and survival of injured fish in river or which are transferred.	d	Observation of injured fish in Grand Ronde basin
4		c	Characterization of injured fish moved to Oregon and Idaho facilities
5	Atlas of salmonid head injuries for agencies, scientific publication.	g	Develop annotated Atlas and scientific publication
6	Regional workshops on headburn	h	Presentations are workshops

### *Objective schedules and costs*

<b>Objective #</b>	<b>Start Date mm/yyyy</b>	<b>End Date mm/yyyy</b>	<b>Cost %</b>
1	4/1999	8/1999	48.00%
2	4/1999	8/1999	10.00%
3	4/1999	8/1999	10.00%
4	4/1999	8/1999	10.00%
5	9/1999	12/1999	19.00%
6	4/1999	4/2000	3.00%
			<b>TOTAL 100.00%</b>

**Schedule constraints.**

The occurrence of fish with head injuries is somewhat variable from year to year. The level of project effort and need for outyear funding will depend on the occurrence and availability of sufficient injured fish to conduct the study.

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**Completion date.**

2001, or earlier, depending of availability of fish.

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**Section 5. Budget**

***FY99 budget by line item***

<b>Item</b>	<b>Note</b>	<b>FY99</b>
Personnel		\$48,928
Fringe benefits		\$5,686
Supplies, materials, non-expendable property		\$8,300
Operations & maintenance		
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		
PIT tags	# of tags:	
Travel		\$11,120
Indirect costs		\$27,392
Subcontracts		\$5,500
Other	Fee	\$12,171
<b>TOTAL</b>		<b>\$119,097</b>

***Outyear costs***

<b>Outyear costs</b>	<b>FY2000</b>	<b>FY01</b>	<b>FY02</b>	<b>FY03</b>
Total budget	\$123,860	\$128,815		
O&M as % of total	0.00%	0.00%		

**Section 6. Abstract**

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The proposal addresses N.M.F.S. Biological Opinion Conservation Recommendation No. 2 (Adult Studies/Adult Passage), Reasonable and Prudent Alternatives (fallback and total dissolved gas) and parts of measures 4.1-4.3, 5.6 and 6.1 of the Columbia River Basin Fish and Wildlife Program (Salmon survival, passage, research and performance). Head injuries in returning adult salmon occur at a frequency of up to 10% or greater at certain fish passage facilities, particularly in the Snake River watershed. They are poorly

described and their cause is unknown. “Headburns” have been observed in E.S.A. listed salmon and other runs and are thought responsible for prespawning mortalities. Fisheries managers uniformly agree an urgent need exists to define the nature of headburn syndrome and assess its cause and consequences in order to formulate strategies to reduce the injuries.

The proposal objectives are to develop a detailed pathological and physiological characterization of headburns in adult returning salmon, evaluate likely causes and determine whether injuries are exacerbated during fish holding and transfer. Close collaboration with fishery agencies is planned. Descriptive pathology, evaluation of lesion development and time course, histological examination, osmoregulatory function assessment, and microbiological methods will be used. A one to three year study is proposed, depending on the variable occurrence of injured fish from year to year.

Critical new information from this project regarding nature, cause and consequences of head injuries should directly lead to remediation strategies. The results will be presented in an annotated atlas for regional fishery agencies, published in a peer reviewed scientific journal and presented at regional workshops.

## **Section 7. Project description**

### **a. Technical and/or scientific background.**

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Head injuries on returning adult salmon and steelhead have been observed at Columbia Basin fish passage facilities since at least sometime in the 1970’s (N.M.F.S. 1997) and have also been noted by field biologists during 1997 including in Endangered Species Act (ESA) listed runs of fish. The injuries are poorly defined and their cause and consequences for the affected fish are known. They are generally referred to as “headburns” or “scalping.” Prespawning mortalities in adult fish are a significant problem, particularly in runs with very low return numbers such as the Tucannon River stocks, and there is concern that headburns are a significant cause of such mortalities.

Such concerns prompted a regional workshop held in Portland, Oregon on January 22, 1997 from which a transcript of proceedings was produced by the National Marine Fisheries Service staff (N.M.F.S. 1997). Subsequently, an interagency work group has been formed to coordinate monitoring for headburns and discuss how the problem should be addressed. From a descriptive pathological viewpoint, headburns are very poorly defined and may represent a mix of different types of lesions with distinct causes and consequences for the fish. There are two brief agency reports resulting from studies in 1996 which describe the condition (Elston 1996; Groberg 1996). Beyond these, we are aware of no peer reviewed scientific publications on the phenomenon. As a result of this lack of definition, a variety of agency managers and specialists consulted during the preparation of this proposal strongly supported an effort to more clearly define the nature of headburns so that meaningful data can be collected and used to make management decisions aimed at remediation of the headburn problem and associated losses of spawning fish.

*Frequency of Headburns.* The frequency of headburns appears to be associated with high water flow years. Groberg (1996) described lesions in Rapid River stocks of spring chinook salmon which were captured at Lower Granite Dam and transported to Lookingglass Hatchery on the Grande Ronde River . The prevalence of head lesions in four groups of fish transported in spring 1996 ranged from 5.9% to 20.5%. The lesions appeared to progress during the time the fish were maintained at Lookingglass hatchery. Presentations made at this workshop indicate that the highest prevalence of headburns is usually found at Snake River facilities such as the Lower Granite Dam adult trapping facility or in Tucannon River stocks of fish. While little is published on headburns, concern is very high, and there are various unpublished reports from fishery experts about their occurrence. For example, headburns were reported in 1997 in fish captured at Oxbow in the Hell's Canyon (Keith Johnson, Fish Pathology Supervisor, Eagle Fish Health Laboratory, Eagle, Idaho, personal communication) and in ESA listed fish (W. Groberg, Fish Pathology Unit, Oregon Dept. Fish and Wildlife - personal communication, regarding observations on salmon in the Grand Ronde basin).

Data from the Lower Granite facility indicated that from 1993 to 1996 , between 4.8% and 10% of fish arriving at the trap had some type of head injury. According to data filed with the Fish Passage Center, Portland, Oregon, in 1997, 596 out of 6,326 (9.4%) spring and summer chinook arriving at this facility had such injuries. Personal communications from Dr. Warren Groberg of the Oregon Department of Fish and Wildlife and the Dr. Keith Johnson of the Idaho Department of Fish and Game indicated that certain groups of fish moved from the Lower Granite facility during specific intervals during spring 1997 had head injury prevalences as high as 30% and that prespawning mortalities were unacceptably high. These higher frequencies could be a result of varying frequency during the season or of development of the lesion after the fish are pass through fishways or are captured or moved to hatcheries in Oregon or Idaho. According to reports at the workshop, the prevalence of head burns at other sites downstream in the basin such as at Bonneville Dam, is lower at around 1% or less of the adult fish passing upstream.

High prespawning mortalities were also reported during the January 1997 workshop on the Tucannon River which flows into the Snake River between Lower Monumental and Little Goose Dams. Tucannon stocks of spring chinook salmon declined to alarmingly low levels in 1994 and 1995. In 1996, about 9% of the fish observed at the fish trapping facility had fresh wounds or head burns. A total of 42 fish were passed upstream and 10 of these died before spawning. In 1997, between May and September, 259 adult chinook salmon were examined. Of these combined hatchery and wild fish, 19.3% had abrasions or wounds in the head area. Hatchery fish tended to have a higher percentage of injuries that wild fish but 10.7% of wild fish passed and recovered above the fish weir were injured.

*Nature and possible causes of headburn.* The Elston (1996) report, based on detailed observations of seven chinook salmon at the Lower Granite fish trapping facility on July 2, 1996, showed that some of the fish had clear abrasive lesions on the head and leading

edges of the fins. In other cases, the lesions were infected by fungi, or alternatively had evidence of healing, making interpretation about initiating cause very difficult if not impossible. While the cause of head burns unknown, a variety of causes have been proposed. These include “fall back” which refers to adult fish that have passed upstream through a fish passage facility falling back downstream. Presumably during the course of a fall back, the fish collide with abrasive concrete or other structures in the fish passageways. Some of the previously observed lesions are clearly associated with abrasive marks (Elston 1996). Other causes or compounding factors that have been suggested as part of the head burn etiology include effects of high water flow years on the ability of fish to navigate the passage facilities, differences in wild and hatchery fish, infectious diseases that may initiate or compound the lesions and lesions resulting from gas supersaturation effects (gas bubble disease or gas bubble trauma).

*Definition of headburn.* It will be impossible to manage and prevent head injuries on returning adult salmon or steelhead without a clear definition of the problem, based on a systematic and representative pathological and physiological characterization of the condition in affected fish. At the Portland workshop in January 1997, it was widely agreed that a clear definition of the headburn syndrome is lacking and is urgently needed in order to focus on the likely causes of the problem. This was reinforced during the preparation of this proposal by fishery biologists from several agencies (see details in section below) who uniformly agreed that it will be impossible to focus on a solution until the nature of the injuries and effects on the fish are more clearly defined.

Thus, there is a fundamental need is for a systematic pathological characterization of the lesions. Until this is accomplished, numerical data describing the incidence of headburns will have limited value because the reported occurrences may be referring to different types of lesions which are not related. Once the nature of the wounds are clearly described, data can be collected, interpreted and used for management decisions with confidence. In addition, the characterization of the lesions, their development or healing, and physiological effects on the fish will help define the cause and consequences of different types of head injuries. Until this basic descriptive work is performed in a systematic and comprehensive fashion, it is unlikely that progress can be made toward reducing the frequency and impact of headburns in adult returning salmon and steelhead, and the contribution of the phenomenon to prespawning mortalities.

*Relationship to N.M.F.S. Biological Opinion and Columbia River Basin Fish and Wildlife Program.* Headburn is a serious health problem for returning adult salmon and steelhead that appears to reduce prespawning survival but the urgent need for a solution has become apparent only in the last year or two. Nonetheless, this proposal address or has direct links to specific objectives in the N.M.F.S. Biological Opinion (Conservation Recommendation No. 2 related to Adult Studies and Adult Passage) and Reasonable and Prudent Alternatives (fallback and total dissolved gas). Similarly, the proposal addresses measures 4.1 to 4.3 and 6.1 of the Columbia River Basin Fish and Wildlife Program related to salmon goals, salmon research, salmon performance and salmon survival. Sections 6.1B.4, 6.1B.7 and 6.1B.8 are concerned with effects of increase spill on adult

salmon passage, fish diseases at fish passage facilities and the extent and identification of interdam adult salmon losses, respectively. Additionally, section 5.6E.1 is concerned with gas bubble trauma in adult salmon, one hypothesis that has been advanced by some as a cause of headburns.

**b. Proposal objectives.**

**b. Proposal objectives**

1. Develop a detailed pathological and physiological characterization of fish with headburns at a high incidence trapping facility (Lower Granite Dam fish passage facility):

- a. using a limited number of non-E.S.A. listed fish which may be sacrificed (see below) and
- b. by examining the character of headburn lesions and condition in transiently held fish at the Lower Granite Dam fish trapping facility, utilizing non-destructive methods.

2. Determine whether headburn lesions are exacerbated during the time the fish are held in the trapping facility.

3. Evaluate the frequency and time course of healing lesions.

4. Evaluate the development and outcome of lesions and survival of injured fish that are transferred to state hatcheries.

5. Develop a systematic annotated atlas of head burns for regional fishery agencies. Publish results of headburn evaluation in a peer reviewed journal.

6. Facilitate and participate in regional multiagency workshops and conferences in regard to headburns.

**c. Rationale and significance to Regional Programs.**

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Prespawning mortalities appear to be an important problem in both E.S.A. listed and unlisted salmonid stocks in the Columbia Basin. Headburn is a pathological syndrome of unknown etiology(ies) that appears responsible for a significant portion of prespawning mortalities in some areas, particularly in the Snake River watershed. Therefore, there is an urgent need to better understand the nature and thus the causes of headburns so that attention can be focused toward solutions to the problem.

The importance of the this problem to regional fishery managers is demonstrated by the January 1997 workshop. The continuing need to resolve this problem was underscored by the organization of a regional task force (December 1997) to support monitoring for headburn. The taskforce is being headed by Mr. Larry Basham of the Fish Passage Center, Portland, Oregon and Mr. Gary Fredericks of the National Marine Fisheries Service, Portland, Oregon. This proposal will provide support for monitoring in that it will better define the headburn syndrome and thus enhance the value of data collection. These individuals and others contacted during the preparation of this proposal all supported the need for a better definition of the headburn syndrome. One of the objectives of this proposal is to participate in monitoring workshops in order to provide more detailed information on the nature of headburns and define systematic and meaningful methods of data collection, based on the results of this study.

Once the headburn syndrome is better understood, it may be beneficial to coordinate findings from this study with other projects aimed at tracking adult fish in the basin, particularly in terms of relating headburn injuries with phenomena such as fall back.

**d. Project history**

**d. Project history.** Not applicable, this is a new project proposal.

**e. Methods.**

**e. Methods**

*Fish used in study and study location.* The Lower Granite Dam fish passage facility will be the primary location for the study of fish because of the historically high occurrence of head burns at this facility and the accessibility of the fish in the fish trap (Elston 1996). In addition, because the Rapid River stock of spring chinook salmon which is trapped at this facility is a strong run which can have returns in excess of the number required for release or hatchery use, a small number of these fish may be sampled destructively by necropsy, subject to permission granted by the Oregon Department of Fish and Wildlife (as was granted for the preliminary study [Elston 1996]) or the Idaho Department of Fish and Game. It is not the intent of this study to destructively sample any more fish than absolutely necessary but it important to note that information about the nature and cause of the lesions will be dramatically improved by the ability to perform necropsies on a small number of representative injured fish. Non-destructive evaluation of additional fish will involve anesthetization and removal of small volume blood samples in some cases.

We do not plan to handle any from E.S.A. listed runs for this study although such fish may be photographed in water.

*Schedule and costs of study.* The prevalence of head burns appears to be related to some degree to river flows. The prevalence of head burns in a given year will determine the effort that can be justified and the project cost for that year. The budget used in this

proposal assumes that project staff will need to be on site at Lower Granite dam for ten weeks during the interval from mid-April through mid-August. A single year of study could be adequate, depending on the fish available for study. The level of effort for a given year may need to be adjusted and the possible need for out year funding will need to be determined based on the occurrence of injured fish.

*Tasks:*

*Task A. Lesion characterization and condition of living fish at Lower Granite Dam fish trap.* Fish which enter the fish trap will be photographed in water using high speed film, a magnifying macro lens and polarizing filters. Selected injured fish will be anesthetized to the minimum plane of anesthesia required for handling and bleeding from the caudal vein, using a target dosage of 70 mg/L of methane tricaine sulfonate (MS-222) or using benzocaine, depending of agency or tribal requirements and uses authorized by the U.S. Food and Drug Administration. The whole fish, head injuries and any other injuries (e.g. abrasions on the leading edges of fins) will be photographed. The length and girth of the fish will be measured. Up to 1.5 mL of whole blood will be drawn from the caudal vein into lithium heparinized vacutainers. Each fish will be returned to the fish trap within two minutes after it reaches a level of anesthetization adequate for handling and will be monitored for recovery in the trap. During handling, the gills will be irrigated with water pumped from the anesthetization tank or recovery tank.

The whole blood will chilled immediately after withdrawal from the fish. Within four hours it will be centrifuged to separate blood from plasma (100 g for 5 minutes), the plasma aspirated and frozen for later sodium analysis. Sodium analysis will be performed according to previously published methods (Kent et al. 1987).

To the extent possible, based on the character of identifying lesions in individuals, fish with head burns will be observed and photographed during their residence time in the fish trap to help evaluate the progression of lesions. Water temperature and dissolved gas measurements made by the facility operators will be recorded at least once daily. If lesions characteristic of gas bubble disease are observed more frequent measurements of total dissolved gas will be made.

*Task B. Necropsy of Rapid River chinook salmon at Lower Granite Dam.* Contingent on permission from the Oregon Department of Fish and Wildlife or the Idaho Department of Fish and Game (depending on the agency responsible for particular batches of fish), up to 20 chinook salmon each year with representative head burn lesions will be captured upon entering the fish trap and euthanized with an overdose of MS-222 (200mg/L). These fish will be necropsied as follows:

A blood sample will be withdrawn from the caudal vein and processed as indicated in task 1.

The whole fish and all lesions will be photographed. Each fish will be inspected for external and internal lesions or abnormalities.

Representative areas of the lesions will be excised and fixed in neutral buffered formalin for histological evaluation.

Wet mount preparations of the lesions will be examined microscopically for the presence of bacteria, fungi and parasites.

The carcass will be frozen and the fish will be subsequently radiographed for spinal injuries.

Bacteriological or mycological cultures may be made on tryptic soy agar, cytophaga agar or other appropriate media if indicated by the wet mount examination or based on the results of ongoing histological evaluations.

Tissues will be frozen for possible viral assays, depending on the outcome of the histological studies.

*Task C. Observations of living fish at Lookingglass Hatchery and Idaho facilities.* Fish transported to Lookingglass Hatchery will be examined for head injuries by Oregon Department of Fish and Game personnel and by project staff. Injuries will be photographed and fish which die prior to reaching spawning condition will be necropsied as feasible. Injured fish will be enumerated daily to the extent possible by observation in their holding areas. Similarly, injured fish moved to Idaho locations will also be examined in conjunction with Idaho Department of Fish and Game personnel.

*Task D. Observation of Injured fish in Grand Ronde basin.* Based on reports from Oregon Department of Fish and Wildlife personnel, fish from E.S.A. listed runs with head injuries have been observed in this basin. In conjunction with O.D.F.W. field biologists and fish health personnel (Dr. Warren Groberg), such fish will be observed and photographed if the opportunity arises.

*Task E. Histological evaluation of lesions.* The tissues fixed for histology will be processed using routine paraffin methods (Luna 1968) or plastic embedding technology if needed (Elston et al. 1982) and examined by Dr. Elston. Selected lesions will be reviewed by Dr. Paul Frelie. Lesions will be examined for the presence of embedded foreign material indicative of abrasive injury, presence of infectious agents, inflammatory responses indicative of specific pathological processes and evidence of healing.

*Task F. Evaluation of infectious agents in lesion development.* If indicated from the pathological examination, fresh or frozen tissues will be processed for viral isolation attempts and fresh tissues will be examined for bacteria, fungi or parasites as indicated at necropsy. These evaluations will be conducted by the Eastern Oregon Fish Pathology Unit of the Oregon Department of Fish and Wildlife, La Grande, Oregon, the Eagle Fish

Health Laboratory, Idaho Department of Fish and Game, Eagle, Idaho or the U.S. Fish and Wildlife Service Lower Columbia Fish Health Center, Cook, Washington.

*Task G. Provide detailed annotated atlas to regional agencies and publish results in peer reviewed scientific journal.* Photodocumented case history descriptions of representative head injuries will be developed. Injuries will be classified and described according to type. This information will be prepared in an atlas format intended for use in monitoring programs for head injuries. The case histories and analysis will be prepared for publication in a peer reviewed journal, such as the Journal of Aquatic Animal Health.

*Task H. Participation in regional workshops.* Results from these studies will be presented at regional workshops. At least one workshop per year is anticipated. In addition, the project principle (R. Elston) will participate in work group meetings related to head injuries, as requested by agencies.

*Critical assumptions.*

- Fish with head injuries will be found during the years proposed for the study.
- Sufficient numbers of fish will return in years of the study to justify destructive sampling of a limited number of fish (Task 1 only).
- Cognizant fishery agencies will support the study and staff will participate in the study.

*Data evaluation.*

Due to the limited knowledge base in regard to head injuries in returning adult salmonids, this descriptive study is required. Although the study is essentially descriptive, the characterization of head injuries will be documented by a systematic approach in which injuries will be typed by definitive characteristics. The purpose of this is to ensure that future monitoring studies, in which large amount of data may be gathered will provide valid and comparative data. To the extent possible, description of injuries will be based on distinct criteria and quantitative description of lesions. The frequency of different types of lesions will be presented according to their time of occurrence.

*Kinds of results expected.*

Detailed pathological description of head injuries.

Information regarding the development of head injuries while adult fish are held in fish traps and after transport to spawning facilities.

Information regarding the ability of injured fish to heal lesions and the effect of exfoliating injuries (loss of skin) on osmoregulatory function in the fish.

Information to support or rule out the role of abrasive injury, infectious agents and gas supersaturation in head injuries.

Annotated atlas of head injuries for use by fishery agencies in monitoring for the conditions.

Publication of results in peer reviewed journal.

**f. Facilities and equipment.**

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AquaTechnics has fieldable camera equipment, compound and stereo microscopes equipped for 35 mm and video photography and various laboratory equipment required for necropsy, blood collection and processing. This equipment has been previously transported to and used at the fish trapping facility at Lower Granite Dam. For the purposes of this study which may require on site evaluation over a period of two months or longer, an 8 ft. by 24 ft. portable office trailer will be rented and placed at the site for the duration of the study. Histology processing will be conducted by a contract laboratory used routinely by AquaTechnics. Virological assays and other follow up microbiological work, as needed, will be conducted by collaborating state or federal agency laboratories.

**g. References.**

**g. References.**

Elston, R. 1996. Investigation of head burns in adult salmonids. Final Report 1996. DOE/BP-96-050-00, Bonneville Power Administration, Portland, Oregon.

Groberg, W. 1996. Investigation of head burns in adult salmonids. Phase 1: Examination of fish at Lookingglass Hatchery in 1996. Addendum to final report 1995. DOE/BP-96-050-00 Bonneville Power Administration, Portland, Oregon.

Kent, M. L., C. F. Dungan, R. A. Elston, and R. Holt. 1988. *Cytophaga* sp. (Cytophagales) infection in seawater pen-reared Atlantic salmon *Salmo salar*. Dis. Aquat. Org. 4:173-179.

Luna, L. C. (ed). 1968. Manual of histologic staining methods of the Armed Forces Institute of Pathology, Third Edition. McGraw Hill Book Company. New York.

National Marine Fisheries Service. 1997. Dissolved Gas Team Meeting Notes. Headburn Workshop. January 22, 1997. BPA Rates Hearing Room. Transcript of workshop prepared by N.M.F.S., Portland, Oregon.

## **Section 8. Relationships to other projects**

**Section 8. Relationship to Other Projects.** This study will require and has the support of other agencies in order to provide follow up on fish transported from the trapping facility and to assist in evaluating the character of lesions in these fish. Specifically, fish moved from the Lower Granite Dam trapping facility to the Lookingglass hatchery in Oregon will be tracked, as well as fish moved to state facilities in Idaho. In addition, permission will be required from the responsible agencies for any fish that will be sacrificed for necropsy (non-E.S.A. listed fish only), as was granted for the necropsy examinations in 1996. Support for and collaboration with this project has been arranged with the following individuals:

Dr. Warren Groberg  
Fish Pathology Unit  
Oregon Department of Fish and Wildlife  
La Grande, Oregon

Arrangements for necropsy of limited number of injured fish from non-listed stocks during years of high returns. Collaboration and laboratory support for follow up of fish trapped at Lower Granite fish trap and transported to the Looking Glass Hatchery.

Dr. Keith Johnson  
Fish Pathology Supervisor  
Idaho Department of Fish and Game  
Eagle Fish Health Laboratory  
Eagle, Idaho

Arrangements for necropsy of limited number of injured fish from non-listed stocks during years of high returns. Collaboration and laboratory support for follow up of fish trapped at Lower Granite fish trap and transported to Idaho facilities.

Mary Peters Swihart  
Fish Pathology Specialist  
Lower Columbia Fish Health Center  
U.S. Fish and Wildlife Service  
Cook, Washington

Laboratory support of submitted samples in regard to infectious diseases.

In addition, Mr. Tom Lorz of the Columbia River Intertribal Fisheries Commission, Mr. Larry Basham of the Fish Passage Center and Mr. Gary Fredericks of the National Marine Fisheries Service, all located in Portland, Oregon, expressed the opinion that work was critically needed to better define the nature of headburns in order to support monitoring and remediation strategies.

## **Section 9. Key personnel**

**Section 9. Key personnel.** The project leader and lead pathologist will be Dr. Ralph Elston, Chief Scientist for AquaTechnics (656 hours on project). Dr. Elston is a specialist in fish health and an American Fisheries Society certified Fish Pathologist. He will be responsible for developing the procedures used in the study and ensuring that integrity of data and will conduct all necropsy examinations, perform other evaluations of fish at the fish trapping facility and other locations, interpret histological preparations, prepare project reports and participate in workshops. Dr. Elston has conducted a previous case report on head injuries and had conducted a variety of studies for public, private and a tribal agency on the health of Columbia River salmonid stocks. Mr. Mark Mayberry (742 hours on project), a fisheries biologist with AquaTechnics, experienced in fish health evaluations, including studies on Columbia River salmonid stocks, will assist Dr. Elston with the project and be on site at the Lower Granite facility during the evaluation period, and will assist with other field evaluation and the report preparation.

Dr. Paul Frelief (Associate Professor, Texas A & M University, time on project 40 hours, subcontractor) is a board certified veterinary pathologist specializing in aquatic species who will provide review of selected histological slides read by Dr. Elston. Dr. Barbara Watrous (Professor, Oregon State University, estimated time on project, 20 hours) is a board certified veterinary radiologist with experience examining fish and will conduct radiographic examination of fish which are examined by necropsy. Agency personnel, such as Drs. Warren Groberg and Keith Johnson will also assist in some of these tasks, although they will not charge to the project.

Dr. Elston is the Chief Scientist and a fish health specialist with AquaTechnics Inc. located in Sequim, Washington, U.S.A. Dr. Elston has affiliations with the University of Washington (Affiliate Professor of Fisheries), Washington State University (Adjunct Professor of Veterinary Pathology and Microbiology) and Pacific Lutheran University (Affiliate Professor of Biology). He is a Fish Pathologist, certified by the Fish Health Section of the American Fisheries Society and member of the American Association of Veterinary Diagnostic Laboratories. Prior to founding AquaTechnics, Dr. Elston was with Battelle, Pacific Northwest National Laboratories, Sequim, Washington for 14 years.

Dr. Elston has been actively involved in fish health management and investigations since 1973. His technical expertise and experience includes investigations on biological mechanisms of and fish and aquatic invertebrate infectious diseases, genetics and nutrition, environmental pathology and toxicology, parasitology, and aquatic animal health management, disease diagnosis and prevention. Health management of wild and farmed salmonid fishes and invertebrates and the relation of animal health to resource management is an area of specialization, including aquatic animal drug registration studies conducted under Good Laboratory Practices. Dr. Elston is the author of over 75 peer reviewed technical publications, book chapters numerous technical reports in the field of fish and aquatic invertebrate health management.

***Examples of relevant recent publications and projects:***

Elston, R. 1996. Investigation of head burns in adult salmonids. Final Report 1996. DOE/BP-96-050-00, Bonneville Power Administration, Portland, Oregon.

Assessment of gas bubble disease in outmigrant salmonid fish in the Columbia and Snake Rivers for Bonneville Power Administration (1995-1997).

Independent auditor of fish health programs at Columbia River Basin salmon and steelhead hatcheries for Bonneville Power Administration (1996-1997).

Elston, R. A., J. Colt, P. Frelier, M. Mayberry, W. Maslen. 1997. Differential diagnosis of gas emboli in the gills of steelhead, *Oncorhynchus mykiss*, and other salmonid fish. Journal of Aquatic Animal Health. In press.

Elston, R. A., J. Colt, S. Abernethy, W. Maslen. 1997. Gas bubble reabsorption in chinook salmon, *Oncorhynchus tshawytscha*, in a simulated smolt bypass system. Journal of Aquatic Animal Health. In press.

***Education***

PhD. 1980, Veterinary Pathology, Cornell University

M.S. 1975, Ecology, University of California, Davis

B.S. 1973 Fisheries Biology, University of California, Davis

**Biological Research**

Collected and analyzed biological data in several areas, including fish health, shellfish health, phytoplankton, entomology, forest pathology and water chemistry. Other duties included lab prep, specimen analysis, disease diagnosis, cartography, and extensive use of microscopy.

**Fisheries**

Duties included overseeing spawning operations, disease certifications, maintenance of health stocks of captive Atlantic Salmon, monthly/weekly reporting, tagging, and liaison with State and Federal agencies.

**Equipment Operation**

Maintained and operated a variety of equipment, including inboard and outboard boats, forklifts, two- and four-wheel drive government vehicles, oxygen monitors, microscopes and standard lab equipment.

**Employment**

1996 – present                      Aquatechnics, Inc.                      Sequim, WA

**Fish Health Technician**

Worked on various projects with fisheries consultant.

1996 (Fall)                      State of Washington, Dept.                      Port Angeles, WA

**Biological Technician II**                      of Fish & Wildlife

Project position.

1987 – 1996                      Stolt Sea Farm, Inc.                      Port Angeles, WA

**Technical Manager**

Atlantic Salmon aquaculture business.

1982 – 1986                      University of Montana                      Missoula, MT  
Bookstore.

Held different positions, most recently as department manager.

**Education**

1978                      Iowa State University                      Ames, IA  
Fisheries and Wildlife Biology

1987                      Oregon State University                      Newport, OR  
Additional course work in fish diseases

Dr. Frelier a board certified Veterinary Pathologist with expertise in aquatic species, particularly including finfish and shrimp. He is an associate Professor of Veterinary Pathology in the College of Veterinary Medicine at Texas A & M University, Texas. In this position he had ongoing research programs related to fish and shrimp health and also serves at the aquaculture diagnostic pathologist for the State of Texas. Dr. Frelier was a co-investigator for a three year project from 1990-1992 grant that determined the major causes of mortality in farmed salmon in Puget Sound, Washington.

***Publications and presentations in the field of fish health***

Frelier PF, Elston RA, Loy JK, Mincher C. 1994. Macroscopic and microscopic features of ulcerative stomatitis in farmed Atlantic salmon *Salmo salar*, Dis Aquat Org, 18:227-231, 1994.

Frelier P. and R. Elston. 1990. Cardiac tamponade in juvenile Atlantic salmon *Salmo salar*. Fourth International Colloquium on Pathology in Marine Aquaculture, Vigo, Spain.

Frelier P. and R. Elston. 1990. Ocular Cataracts in Atlantic Salmon from Puget Sound. Fourth International Colloquium on Pathology in Marine Aquaculture, Vigo, Spain.

Eldar A, Lawhon S, Frelier PF, Assenta L, Simpson B, Varner PW, Bercovier H: Restriction fragment length polymorphisms of 16S rDNA and of whole rRNA genes (ribotyping) of *Streptococcus iniae* strains from the United States and Israel. Federation of European Microbiological Societies Letters, 151:155-162,1997

Frelier PF, Sis RF, Bell, TA, Lewis DH: Microscopic and ultrastructural studies of necrotizing hepatopancreatitis in Texas cultured shrimp *Penaeus vannamei*, Vet Pathol 29:269-277, 1992

***Education and Certification***

Diplomate of American College of Veterinary Pathologists  
Phd. 1981 Veterinary Pathology, Cornell University  
D.V.M. 1974 University of California, Davis  
B.S. 1972 Animal Physiology, University of California, Davis

Dr. Watrous is a Professor of Radiology, College of Veterinary Medicine, at Oregon State University in Corvallis, Oregon. Dr. Watrous has extensive experience as a diagnostic and research radiologist in a variety of domesticated animal species, including work with trout and salmon. She has held Adjunct and Visiting professorships including University of Pennsylvania New Bolton Center (1988-89), Tufts University in Massachusetts (1988), Ross University, West Indies (1997). Dr. Watrous is an member of the Phi Zeta Veterinary Honor Society, Phi Kappa Phi Honor Society, American Veterinary Medical Association, Radiological Society of North America, International Veterinary Radiology Association and the European Association of Veterinary Diagnostic Imagers.

***Recent projects and publications:***

Evaluation of triploidy induced anomalies in the spinal structure of rainbow trout. Study in progress.

Transit of barium sulfate and contrast appearance of the gastrointestinal tract in fingerling salmonids.

Watrous BJ, Hultgres BD, Wagner PC. Osteochondrosis and juvenile spavin in equids. AM J VET RES 1991;52(4):607-613.

Watrous BJ, Cook SF, Kelley JP. The use of radiology in the scientific investigation of shark attacks. CHONDROS 1992;3(5):1-6.

***Education and Certifications***

B.S. with Honors in Veterinary Science, University of California, Davis, 1972

D.V.M. with High Honors, University of California, Davis, 1974

Diplomate, American College of Veterinary Radiology, 1978 to present.

**Section 10. Information/technology transfer**

**Section 10. Information/technology transfer.** As indicated above, this proposal was developed because fisheries managers, some of whom participate in a regional work group to evaluate adult salmonid head injuries, encouraged the submission. Therefore, presentation of the results of this evaluation at meetings of this regional work group will be a key means of transferring the information developed during the project. In addition, a color pictorial atlas of head injuries, based on detailed photographic material obtained during the study, will be prepared. The intention of this atlas is that it will be used at monitoring facilities so that head injuries can be accurately recorded by type. Finally, to establish a credible record of the work, a report on various types of head injuries with

information on possible or confirmed causes will be prepared for submission to a peer reviewed technical journal such as the Journal of Aquatic Animal Health.