Appendix 7. Introduction to Common Fish Diseases

Fishing is a very popular outdoor activity in Minnesota and many fishermen are interested in the welfare of the fish. Consequently, the fish they catch are often scrutinized for anything unusual, and fishery biologists and fish pathologists are questioned for identification of these conditions. Because fish, like humans are attacked by a wide variety of parasites, bacteria, viruses and anomalies, many inquiries are received every year.

The specific identify of many parasites, bacterial and viral diseases, and tumors can only be accomplished through complex laboratory techniques. Any unusual specimens not described should be forwarded to the pathology laboratory. Live specimens are most desirable, but fresh refrigerated, or iced material is good, although material preserved in 10% neutral buffered formalin is also suitable. If there is any question about the method of preservation, the pathology lab should be contacted.

Fish are no different than other animals where disease is concerned. A healthy animal is more resistant to disease than a weak animal, or an animal under stress. Fish respond physiologically to environmental change. A fish's body temperature changes with water temperature. Metabolism also changes with water temperature. If the temperature changes very rapidly, physiological processes are drastically altered, sometimes causing death. Such things as low oxygen, excess silting, lightning, excessive current, super saturation of water by gases and all kinds of pollutants exert stresses on fish. If fish are not damaged directly by these things, they may be weakened, their resistance lowered, and their vulnerability to disease caused by parasites, bacteria, and viruses increase.

Common terminology used to describe various stages in the life cycle of parasites and pathological conditions are defined below:

1. Parasite: An organism which lives in or on another organism (host) and which depends on the host for its food, has a higher reproductive potential than the host, and is suspected of harming the host when present in large numbers.

2. Host: An animal or plant which harbors or nourishes another organism.

3. Accidental host: The host in which a parasite of another animal will live for a variable length of time.

4. Definitive host: The host in which a parasite passes its adult or sexual existence.

5. Intermediate host: A host in which a parasite passes a larval or non-sexual existence.

6. Cercaria: Larval trematode form, which produces rediae or sporocysts in infected snails.

7. Metacercaria: Larval stage of trematodes between cercarial and adult stage, a more or less quiescent stage. The larval stage of flukes, which follows the cercarial stage.

8. Pleurocercoid: Larval stage of cestodes.

9. Cestode: Girdle-form. Tapeworms.

10. Trematode: The flukes. Monogenea: ectoparasitic in general, one host; Digenea: endoparasitic in general, two hosts or more.

11. Nematode: A diverse phylum of round worms, many of which are plant or animal parasites.

12. Lesion: Any visible alteration in the normal structure of organs, tissues, or cells.

13. Stress: A state manifested by a syndrome or bodily change caused by some force, condition, or circumstance in or on an organism or on one of its physiological or anatomical systems. Any condition which forces an organism to expend more energy to maintain homeostasis.

14. Infection: The introduction or reentry of a pathogen or parasite into a host, resulting in the presence of the pathogen or parasite within the body, tissues, or cells of the host, whether or not this results in overt disease.

15. Disease: A morbid process or condition of the body or its parts, having a characteristic train of signs that distinguishes it from other morbid processor conditions and from the normal state. Any state which results in a gradual degeneration of homeostasis.

PARASITES

Asian Tapeworm - Bothriocephalus acheilognathi (**SA**)

Bothriocephalosis is an intestinal infection of certain fish by the cestode Bothriocephalus acheilognathi, a Pseudophyllidian tapeworm. This tapeworm has been reported in Asia, Europe, Australia, South Africa and North America. In North America it has been reported in Mexico, British Columbia throughout the southern US and in New Hampshire, New York and Hawaii. Fish become infected after ingesting infected copepods and development of the worm occurs in the anterior intestinal tract. Bothriocephalus is a thermophile that has an optimal temperature for growth and maturation above 25C.

Most members of the Family Cyprinidae are considered potential hosts, with the exception of goldfish. Infections have also been reported in species in the following families: Siluridae, Poeciliidae, Percidae, Centrachidae, Gobiidae, and Cyprinodontidae.

Bass Tapeworm - Proteocephalus (**SB**)

Several species of *Proteocephalus* may be found in a wide variety of fresh water fish species. This tapeworm has been given the common name of the bass tapeworm as *Proteocephalus ambloplitis* is commonly found in the adult stage in the intestine of both largemouth and smallmouth black bass. The *plerocercoid* larvae, however, are found in the body cavity and internal organs of many species of fish, especially rock, large and smallmouth bass in many lakes and streams. It is the larval *plerocercoid* stage which is most often seen, and which causes damage to fish. The *Plerocercoids* develop in the body cavity and internal organs, especially the liver and ovaries. Because they do not encyst, but continue to move around, they destroy tissue and cause multiple tiny hemorrhages. This may produce adhesions and a brown color in the body cavity. Heavy ovarian infestation may cause sterility.

The life cycle of this tapeworm involves a larger bass eating a smaller fish (intermediate host) infested with plerocercoids. Research has shown that the pleurocercoid may also migrate from the body cavity directly into the gut, thus omitting the intermediate host stage. These larval tapeworms attach to the intestinal wall of the larger fish and grow to maturity. Eggs produced by the adult worm pass into the water where they are fed upon by copepods and amphipods. Inside these invertebrate hosts a larval form emerges from the egg, penetrates into the crustacean's body cavity, and develops into a pleurocercoid. When an infested crustacean is ingested by a small fish, the pleurocercoid emerges, burrows through the intestinal wall of the fish, and migrates into the visceral organs where it may cause extensive damage as a plerocercoid. The pleurocercoid may live several months in the internal organs of a fish.

The bass tapeworm will not infest humans.

<u>Ceratomyxa</u> <u>shasta</u> (**SC**)

Ceratomyxosis is a disease of salmonid fishes caused by the myxosporidean Ceratomyxa shasta. The parasite has a tropism for the intestinal tissue of the fish and causes high mortalities in susceptible strains of salmonids. Ceratomyxosis is an important parasite in the Pacific Northwest because it not only causes losses in hatchery reared and wild juvenile salmonids but also contributes significantly to prespawning mortality in adult salmon.

Clinical signs vary among salmonid species. Infected juvenile rainbow trout and steelhead become anorexic, lethargic, and darken. Ascites may distend the abdomen, the vent may be swollen and hemorrhaged and exopthalmia is common. Internally, the intestinal tract becomes swollen and hemorrhaged with the intestinal contents mucoid and caseous material lines the intestine and cecca. The entire digestive tract may become hemorrhaged and necrotic.

This lifecycle also involves an intermediate host and is not present in the state.

Chilodonella (**SD**)

These ciliated protozoans are most frequently found on warmwater fish such as pike and carp, although infestation of trout fry in hatcheries is not uncommon.

The parasites are tiny, 50 to 70 microns long, and cannot be seen without magnification, although heavily parasitized fish may show blotchy gray areas

on the surface of the skin. Under magnification the parasites may be seen as tiny, motile, oval bodies covered with fine cilia.

When Chilodonella occurs in very great numbers on a fish, particularly on the gills, it causes the fish to produce great quantities of mucus, which impair respiration. Affected fish may become lazy, lie on their sides, rise to the surface, and eventually die. The parasite shows a preference for debilitated or undernourished fish. It is frequently observed on northern pike in the spring of the year as they enter a marsh for spawning.

The parasites are not harmful to man.

Diplostomum spathaceum (**SE**)

Diplostomum spathaceum utilizes many species of fishes as a second intermediate host, the metacercariae localizing in eye tissue. Several fish-eating aquatic bird species, especially gulls, are the primary hosts of this fluke.

The life cycle of *D. spathaceum* begins as an adult trematode in the intestine of gulls or other piscivorous birds. The body is 0.3 to 0.5 mm in length and distinctly divided into a flattened anterior fore body and a more cylindrical and narrower hind body. Eggs are shed and passed in feces to the water. They hatch in about 21 days at summer water temperatures into free-swimming ciliated miracidia.

Miracidia seek aquatic snails for a first intermediate host; only lymnaeid snails are acceptable. The miracidia penetrate the hepatopancreas of the snail and metamorphose to a mother sporocyst, then to one or more daughter

sporocysts. Each produces many cercariae which are released into the water. The free-swimming cercariae seek second intermediate hosts.

The usual route of transmission from the snail to the second intermediate host is through water and active penetration of the cercariae. However, much evidence points to the fact that transmission is possible by fishes feeding on snails containing cercariae. Some cercariae which enter the skin, fins, and gills enter the blood stream and are carried to the eyes within 30 minutes of the time of penetration.

The snails cause a parasitic blindness diagnosed by cataract and isolation of the parasite.

Myofibrogranuloma (SF)

Myofibrogranuloma (MFG) is a muscular dystrophy-like anomaly of walleye in which the skeletal muscle has undergone profound structural changes. The myopathy is recognized by its swollen, coarsely fibrous, granular, and fatty characteristics. The lesion has an opaque yellow-brown color. Included in this pattern of striated muscle deformation is a consolidation and fusion of contiguous muscle fibers to form prominent aggregates of rough, cordlike strands, which eventually undergo a coagulation necrosis and calcification. A simple description is that it looks like the flesh has been freezer burned. The lesions are typically found along the vertebral column while filleting.

Myofibrogranuloma has been found exclusively in adult walleye whose ages range from 3 to 10 years. The sex frequency ratio of the disease is about equal. A higher frequency of this anomaly has been observed to occur in

walleye from comparatively small, fertile lakes and ponds in which the species is maintained exclusively by periodic stocking of hatchery-reared walleye.

Argulus, fish lice (**SG**)

Argulus sp. have been given the common name fish lice as they have the ability to creep about over the surface of the fish. These are large copepods and consequently, they are conspicuous objects on the fish they inhabit. At first glance they look like a scale but on closer examination are seen to be saucer-shaped and flattened against the side of the fish. They have jointed legs and two large sucking discs for attachment, which may give them the appearance of having large eyes. Argulids penetrate the skin of the host fish, inject a cytolytic substance, and feed on blood. Lice prefer those parts of the skin best supplied with blood vessels like the mouth region, the operculum, and the base of the fins.

Heterosporis (**SH**)

A microsporidea recently detected in the muscle of Yellow perch in the Eagle Chain of lakes in Wisconsin, Leech Lake in Minnesota and Lake Ontario. This parasite has been found in Walleye, northern pike and tullibee. Experimentally Fathead minnow, rainbow trout are susceptible and Largemouth bass and sunfish are somewhat refractory. Heterosporis has been reported in aquarium species from Germany, France and Thailand.

The parasite infects muscle cells which cause the cells to have a white appearance. The parasites life cycle is not completely known but research is underway to learn more.

Ichthyopthirius multifiliis, Ich (**SI**)

A common disease of hatchery and aquaria fish is white spot, a condition caused by large ciliated protozoans. The adults of this parasite are up to 1 mm in diameter, and may be seen with the unaided eye as tiny white spots on affected fish. The parasites live under the epithelial layers of the skin, fins, and gills of many species of fish, especially young fish. They are found more frequently on warmwater fishes than on fish from coldwater because low temperatures inhibit their activity.

When the parasite has grown to maturity, it leaves the host and becomes enclosed in a cyst. Within this cyst multiplication occurs resulting in the production of from 400 to 2,000 young parasites. These are also ciliated, and when they leave the cyst, swim actively until contacting a fish. If a fish is not found within a few days, the parasites die. If they find a fish, they burrow into the skin, migrate for a time, and then grow to maturity. The entire life cycle takes from 4 days to 3 weeks, depending on the water temperature.

White spot can be very serious, causing high mortality, especially when fish are under crowded conditions and heavy infestation occurs.

Proliferative Kidney Disease (**SK**)

Proliferative Kidney Disease is a condition of salmonids first recognized in the Hagerman Valley of Idaho. The disease has been a major problem in Europe and the British Isles for many years, where it is recognized as a major problem affecting rainbow trout production, especially in Italy and France.

Affected fish typically have a distended abdomen with longitudinal swelling of the body wall at the level of the lateral line. Some fish may show dark body coloration with varying degrees of mono or bilateral exopthalmia. Prior to

death, respiratory distress is obvious, probably due to a pronounced anemia. Internally, there is gross enlargement of the kidney into swollen, grayish, bulbous ridges. The swim bladder may be displaced and distorted and the abdominal swelling may be compounded by excess peritoneal fluid. The spleen may be smaller than normal or massively enlarged with patches of grayish mottling beneath the capsule.

Lernea, anchor worm (**SL**)

The genus *Lernea* contains species of copepods parasitic on fish. Identification of *Lernea* is based on the morphology of the adult female which is seen protruding from the skin of the host. *Lernea* is a long slender copepod which, when attached, gives the appearance of a soft stock with two egg sacs attached. Actually, the head-end is buried in the flesh. This end has large, leathery horns, which aid in the identification of the parasite.

Lernea eggs hatch in 1 to 3 days, releasing larvae, which are free swimming. The larvae pass through five successive stages before the female attaches to a fish, where they penetrate the skin and attain a permanently fixed position. Then they increase in length up to ¾ of an inch, and develop the embedding anchors. After reaching adulthood, egg sacs and eggs are formed completing the life cycle.

Bladder Worm (**SM**)

This roundworm is a common parasite of trout, salmon, smelt, and whitefish. As an adult, the worm is found in the swim bladder of the above fishes. These worms belong to the genus *Cystidicola*.

The adult worms found in the swim bladder of fish are from 1 to 2 inches in length, and usually a translucent white in color. They produce eggs, which eventually reach water and are ingested by crustacea. Here the juvenile worms develop to a stage infective to fish. When infested crustacea are eaten by a suitable fish, the larval nematodes are freed and migrate to the swim bladder. Here, they grow, mature, and produce eggs thus completing the life cycle. It seems probably that larger fish, such as lake trout, which do

not feed on crustacea, develop heavy infestations by consuming smaller fish, which have eaten infested crustacea and still have invasive juvenile worms in their guts.

The worms cause little harm to the fish hosts, even when large numbers are present in the swim bladder. Infested fish appear healthy, but no studies have yet been reported dealing with the effects of this parasite upon its host.

This parasite is not harmful to man. Since the swim bladder is discarded in dressing the fish, the parasites are not objectionable in fish prepared for human consumption.

Neascus – Black Spot (SN)

These parasites are easily discerned as obvious pigmented cysts (the size of a pinhead) slightly raised from the skin or fins, or sometimes in the mouth or flesh. The parasites commonly infest rock bass and other sunfish, bass, pike, minnows, and other fish species. Various species of black spot are found in practically all parts of the world. The black spots are actually pigmented cysts of larval trematodes, which mature, in fish-eating birds. The life cycle is snail to fish to bird.

Fish may be heavily infested, yet the parasites do relatively little damage in most cases and do not obviously affect growth or longevity of the fish. There is some evidence, however, that a massive infestation on a young fish may cause excessive blood loss, physiological stress, and sometimes though not frequently death.

These trematodes are incapable of infesting man, and even a heavily infested fish is safe to eat. It may be more aesthetically pleasing to skin a very heavily infested fish before eating. Cooking kills the parasite.

Ergasilus (**SR**)

Ergasilus is a small, Cyclops-like gill parasite, which is found attached to the gills of a wide variety of fish species by means of clasper-like claws. These copepods appear as small, elongated white spots on the gills of fish. Impregnated females are the only Ergasilids found on fish and they produce eggs at intervals of 3-12 days depending upon the temperature and species of parasite. Up to 1 million eggs may be produced during the 1 year life span of the female. Eggs hatch in 2-4 days and another 10-70 days is required for the copepod to reach sexual maturity.

Myxobolus cerebralis, Whirling Disease (**SW**)

Myxobolus cerebralis may be difficult to detect because the life cycle of the parasite includes two alternate hosts (salmonids and the aquatic oligochaete worm Tubifex tubifex) and the extended time required for sporogenesis in the salmonid host. The species most susceptible are rainbow trout, sockeye salmon, and steelhead. Brook trout, cutthroat trout, atlantic salmon and Chinook salmon are moderately susceptible; brown trout and bull trout, coho salmon and splake are partially resistant. Conflicting data are present for grayling and lake trout but in general these species may be considered partially resistant. Fish are most susceptible if exposed when young, however older fish may become infected and act as carriers of spores.

Development of myxospores is temperature dependent, requiring a minimum of 90 days at 16-17C and 120 days at 12-13C

Gyros (**SY**)

Fish culturists frequently observe the symptoms of "Gyro" infestation. "Gyros", *Gyrodactylus elegans* and *Dactylogyrus sp.* seldom become a serious menace to fish in nature. However, they may become a problem in hatcheries where fish are closely crowded and the worms may be easily spread from one fish to another. Infested fish can be seen "flashing" as they rub themselves against the sides and bottom of the trough or stream in an effort to rid themselves of the parasites.

"Gyro" infestation can be identified only with the use of a microscope as the worms are quite small, 0.5 to 0.8 mm long. The posterior end of these worms is disc shaped and equipped with hooks, which are used to hold the parasite to the host. These hooks penetrate the skin or gill tissues, creating open sores, which frequently become infected with fungus, and may serve as portals of entry for pathogenic bacteria and viruses.

Gyrodactylus may be distinguished from worms belonging to the genus *Dactylogyrus* by its absence of eye spots in the anterior end. *Gyrodactylus* may live almost anywhere on the host, but it is usually most abundant on the fins, especially the dorsal and caudal. "Gyros" give birth to live young, which are already well developed and immediately become attached to a fish host.

Dactylogyrus is easily identified by the presence of two pairs of eyes, which appear as small black dots near the anterior end. This genus differs from *Gyrodactylus* by laying eggs, which become attached to the gills of the host.

After the young hatch, they require some time to grow to maturity. The eggs of *Dactylogyrus* may resist treatment and hatch later, so treatment must therefore be repeated to kill the newly hatched young before they mature and lay eggs.

Yellow Grub (**SY**)

This is the common "grub" found in our freshwater fish as a yellow worm up to ¼ inch long just under the skin, or in the flesh. Yellow grub has been reported from so many kinds of freshwater fish in North America that apparently no fish is immune to it. The grub is the larval stage, which must be eaten by fish-eating birds, such as herons and bitterns, to develop. The grub matures in the throat of the bird, and eggs wash into the water from the bird's mouth when feeding. The eggs hatch and the first larval stage (miracidia) swim by means of fine hair like cilia until they find a snail of the genus *Helisoma*. Unless they find this snail, they die within several hours. In the snail they go through several developmental stages during which they multiply a thousand fold, finally leaving the snail as a free-swimming cercariae. Unless the cercariae find a fish within a few hours, they die. When they find a fish, they burrow through the skin and encyst, where they develop into metacercariae, which are the yellow grubs. There they remain until eaten by the bird host, thus completing the life cycle.

The grubs may live for several years in the fish, thus in many lakes rather heavy infestations accumulate and the fish are classed by fishermen as unfit for food.

Normal cooking of the fish destroys the grub.

Leeches (SZ)

Certain leeches attack fishes, but do little damage unless present in large numbers. The damage done to the fish is proportional to the number of leeches present and the amount of blood they remove. Leeches attach periodically to fish, take a large blood meal, and leave for varying periods of time.

The true fish leeches belong to the family *Piscicolidae* and are related to the common earthworm. Leeches usually have a greenish brown color, are from ¼ to 1 inch long, and may be found in the mouth, on the gills, fins, or body of bluegill, perch, and many other fishes. All leeches are composed of only 34 true segments with each segment subdivided into a definite and constant number of superficial annuli. Leeches have two suckers, one at each end. The anterior one surrounds the mouth and may be large or small, and lip-like. The caudal sucker faces ventrally and is much larger, disclike, powerful, and expanded over central attachment pedestal. Leeches are flattened dorsoventrally and are highly muscular and contractile.

FUNGAL INFECTIONS

Fungal diseases are encountered by all freshwater fishes at one time or another. Under fish culture conditions, certain fungi are especially troublesome. Fungi, which infect fish or fish eggs, are generally considered to be secondary invaders after tissue injuries or tissue death. However, once the fungus begins growing, lesions continue to enlarge and potentially cause death.

Good sanitation and cleanliness are absolutely essential to effectively control fungal infection under intensive culture conditions. There are two general methods for the control of fungal infections on eggs: mechanical and chemical. The mechanical method used for salmonid eggs involves the removal of dead and/or infected eggs at frequent intervals during incubation. This method is time consuming and there is a risk of injuring healthy eggs in the process.

There are three prominent chemical controls for fungal infections: formalin, salt, and malachite green. Malachite green has never been cleared for fishery use.

Branchiomycosis (**SM**)

Branchiomycosis is a fungal disease affecting the gills of freshwater fish. The fungus grows within the blood vessels and reduces the blood supply to the gills causing loss of oxygenation of the blood. The gill tissue becomes necrotic and sloughs away, which is why the condition has been referred to as “gill rot”.

Fish having acute to subacute infections may be weak and lethargic and have labored opercular movements. Gills may appear bright red from impaired circulation. Some areas of the gill may be white to brown depending on the stage of necrosis. Subacute cases develop more slowly and a definite marbling appears on different sections of the gills as necrosis advances. The gills may eventually develop a very ragged or corroded appearance.

Saprolegnia (**SP**)

Fungus, or water mold, is frequently found on fish in the natural environment and in fish hatcheries nationwide. The appearance of grayish-white, furry, or cottony like patches is n indication of a fungal infection, most likely caused by *Saprolegnia parasitica*. Several other species can also be found, but *Saprolegnia* is the most common. Water with a high silt or dirt particle content will mask the white fungal color to a brownish color as the particles collect on the fungus.

The fungal growth consists of a mass (mycelium) of nonseptate filaments (hyphae) each of which is about 20 microns in diameter. This fungus reproduces sexually and asexually. The lesions are circular and grow by radical extension around the body until lesions merge. At this point, the lesions may appear dark gray or brown because the mycelium traps mud and silt.

Fungus attacks on fish are considered to be secondary invaders. Any physical injury, such as produced during spawning, or migrating activities, or by infection by external parasites or bacteria may enable fungus to gain a foothold on the fish. Once the protective mucus covering of the fish is broken, an opportunity is offered for the zoospores to germinate and penetrate the epithelium at the point of injury. Fungal infections rarely

develop on strong fish, even in injuries. It develops rapidly on fish, which have been weakened by stresses such as spawning activity, disease, overcrowding, and rapid environmental change.

BACTERIA

GILL DISEASES

Nearly all gill diseases are going to require the use of a microscope and some fish pathology training in order to be able to determine the actual pathogen responsible.

Flexibacter columnaris, Columnaris (**BC**)

Columnaris disease is an acute to chronic bacterial infection that infects anadramous salmonids and virtually all species of warmwater fish. It occurs both as external or systemic infections and under certain conditions, can result in significant losses of hatchery reared fish. Epizootics of columnaris disease frequently cause substantial mortalities in natural fish populations primarily in the spring as water temperatures in the shallows warm and primarily in crappies, other sunfish, and catfish. The disease was named columnaris because of the haystack pattern which the bacteria tend to form on the gill lamellae.

Columnaris disease is caused by the bacteria *Flexibacter columnaris*. The disease begins externally on the body surfaces and gills but lesions vary. Lesions of scaleless fish, begin on the body as small circular erosions of the skin, which have gray-blue necrotic centers, and red margins surrounded by a ring of inflamed skin. As the disease progresses, these lesions spread over the rest of the body. In scaled fish, necrotic lesions begin at the outer margins of the fins and spread inward towards the body. Columnaris also causes extensive gill necrosis. In well advances cases, bacteria may also be

isolated using special growth media. generally fish are susceptible to columnaris at water temperatures from 15-30C.While columnaris occurs in every month of the year it tends to be seasonal, especially in temperate climates where it peaks during March through April and again in autumn with decreased incidence in summer and winter.

Bacterial Gill Disease, other Flexibacter (**BG**)

Bacterial gill disease is a common external infection of hatchery reared salmonids and occasionally warmwater species reared under intensive conditions. *Flavobacteria sp*. and *Cytophaga sp*. have been isolated from bacterial gill disease cases. BGD is a superficial infection of gill epithelium by large numbers of filamentous bacteria resulting in fusion and clubbing of gill lamellae. BGD usually occurs as a result of overcrowding and poor environmental conditions. Fish infected with BGD are usually lethargic, refuse food, ride high in the current, orient themselves into the current, space themselves equidistant from each other, and the tips of the gills may appear slimy with whitened tips. The most important fact is that bacteria causing bacterial gill disease do not cause necrosis.

INTERNAL

Coldwater Disease, Cytophaga psychropila (**BD**)

Coldwater disease, caused by the bacteria Flexibacter psychrophilus, is a common problem in salmonid fish culture. The bacteria is usually pathogenic at less than 10C. When temperatures in Spring are 4-10C the bacteria begins to show itself and mortality begins to rise. Mortality is most acute at 15C.

Coldwater disease causes epithelial erosions and necrotic skin lesions and often becomes systemic. Young fish show damage to the skin covering the yolk. In older fish, typical signs of peduncle disease appear. External signs include: tail darkening, white or bluish areas behind dorsal or adipose fins; loss of epidermis on dorsal or posterior surface; erosion of the dermis on the peduncle; erosion of lower jaw or snout; gill hemorrhages and edema. Internal signs: generally not remarkable but sometimes has enlarged spleen with myriad number of filamentous rods; and petechial hemorrhages of adipose tissues.

Edwardsiella ictaluri, Enteric Septicemia of catfish (**BE**)

Enteric septicemia is a chronic, to sub-acute disease in channel catfish with nearly definitive clinical signs. Diseases fish hang listlessly with a "head up-tail-down" posture at the surface, spin in circles followed by morbidity, and death. Affected fish have pale gills, bulging eyes and occasionally enlarged abdomens. Small, circular, pale lesions of 1 to 3 mm in diameter appear on the flanks and backs of infected fish and progress into inflamed cutaneous ulcers.

Although ESC has been diagnosed during every month of the year and in a wide range of water temperatures, it is considered a seasonal disease occurring primarily when temperatures range from 18-28C in late spring to early summer and again in autumn; the optimal temperature is 20-25C.

Aeromonas salmonicida, common name Furunculosis (**BF**)

Furunculosis is a generalized internal infection prevalent in trout and salmon. The disease was first described in Germany in 1894. Affected fish darken, stop feeding and develop hemorrhages at the bases of the fins. The furuncle occurs in long term chronic disease but not in rapidly developing epizootics. Internally, hemorrhages occur in the intestine, abdominal walls and heart. The stomach is devoid of food and the intestine may be filled with a yellowish mucoid material.

Goldfish ulcer disease and carp erythrodermatitis are also caused by Aeromonas salmonicida. Although A. salmonicida infections usually occur in salmonids and less often in common carp and goldfish, the causative

bacterium also infects many other species of warmwater and coldwater fishes-both freshwater and marine.

Renibacterium salmominarum, Bacterial Kidney Disease (**BK**)

Bacterial Kidney disease is an internal infection that commonly causes high mortality in cultured salmon and trout. The disease course is typically chronic but acute outbreaks sometimes occur, especially at moderate temperatures of 13-18C. Kidney disease progresses slowly. Signs of the disease may not be evident until the disease is well established. External signs typically include exopthalmia and small closed blisters or open sores. The unruptured blisters contain fluid composed of blood cells, tissue and large numbers of bacteria. Internally, the kidneys are the organs most often affected; they become swollen and develop discrete white areas that contain bacteria and host cell debris. Hemorrhages occur in the body wall and testes. The hindgut is sometimes bloody and filled with white or yellow viscous fluid.

Although BKD is seen mainly in fresh water, mortality is also significant in salt water. BKD develops slowly but its progress is affected by water temperature. At 15-20C infected fish begin to die 21-34 days after infection, but at 7C no fish died until 60-71 days post infection.

Yersinia ruckeri, Enteric Redmouth (**BR**)

Enteric Redmouth disease, an internal bacterial infection of fishes, is principally known for its occurrence in rainbow trout, in which it was first seen in Idaho in the 1950's. The causal organism was named Yersinia ruckeri. In early acute disease outbreaks, the affected trout are typically lethargic, off feed, and have hemorrhages at the bases of the fins, in and around the mouth, and oral cavity . Gill filaments also may have hemorrhages along with the surfaces of internal organs and in the lateral muscles. The lower intestine is often inflamed and filled with a thick yellow fluid. One or

both eyes may protrude, have hemorrhages around the ocular cavity and iris, and commonly rupture. Fish that survive darken in color and seek shelter or withdraw from other fish.

Although Y. ruckeri was first isolated in Idaho, in the 1950's, it has now been proven that the bacteria was present in West Virginia and Australia at the same time. Experimental evidence suggests that incubation time is 5-10 days at 13-15C.

VIRUS

Channel Catfish Virus (**VC**)

Channel catfish virus is an acute communicable infection of cultured fry and fingerling channel catfish. The virus is a Herpes Virus, named Herpesvirus ictaluri. Infected fish swim erratically or convulsively, sometimes rotating along their lateral axis. Moribund fish hang with their head up at the surface or sink to the bottom become quiescent, respire weakly but rapidly prior to death. Clinical signs include abdominal distention due to fluid in the body cavity, exopthalmia, pale gills, and hemorrhages at the bases of the fins.

Channel catfish virus occurs in all southern, and most other states where channel catfish are cultured. As of this date it has not been found in wild or feral populations. Juvenile channel catfish are most susceptible to CCV but fingerling blue catfish and channel catfish X blue catfish hybrids are also susceptible by injection. Most clinical CCV outbreaks occur during June through October when water temperatures are above 25C.

Viral Hemorrhagic Septicemia (**VE**)

Viral Hemorrhagic Septicemia is a viral disease of trout, salmon and several nonsalmonid fishes (northern pike, grayling, whitefish, pollan, sea bass and turbot). The disease occurs in susceptible fish of any age and is known to cause significant losses to fish populations. Until recently, when it was isolated in Washington State, VHS virus was confined to European and Scandinavian countries.

Clinical signs of VHS vary with the severity of the infection. In acute infections, death is rapid and numerous. Fish are sluggish, appear dark in color, have exopthalmia, and are anemic. Externally, hemorrhaging occurs in the eyes, skin and gills and at the bases of the fins. Pinpoint hemorrhages appear internally in tissues around the eyes, in skeletal muscle and in the organs. The liver is enlarged and discolored and the kidneys are red and thin. In chronic infections, deaths are numerous but they occur over a greater period. External signs of the chronic form are similar to the acute form, but hemorrhaging is not as extensive. The abdomen is swollen from accumulation of fluid in the liver, kidneys and spleen. Internally the liver is pale and the kidneys gray.

The virus is a member of the Rhabdovirus group. The incubation period can be 7-15 days depending on water temperature. Outbreaks usually occur in water temperatures below 15C and cease when water temperatures rise. The greatest loss of infected fishes is between 3-5C.

Infectious Hematopoietic Necrosis Virus (**VH**)

Infectious Hematopoietic necrosis virus is a disease of fry and fingerling rainbow trout, Chinook and sockeye salmon, and occasionally of yearlings. The virus has only been isolated from fish showing signs of the disease and

from sexually mature carrier adults. Coho salmon are also suspected of acting as carriers but coho fry are resistant to the disease. IHN is primarily a west coast disease being found in California, Oregon, Washington, Alaska, Idaho, British Columbia and Japan. In the mid 1970's was found at a private fish hatchery near Brownsville, Mn.

Mortality can reach up to 90% of an infected population. Clinical signs include: distended abdomen, exopthalmia, petechial hemorrhage, no food in gut, pale liver, spleen cherry red, and transparent kidneys.

Largemouth Bass Virus (**VL**)

Largemouth Bass virus, the cause of largemouth bass virus disease was the first systemic virus isolated from any centrarchid. The initial isolate came from Santee Cooper reservoir, South Carolina in 1995. The virus has been shown to be an iridovirus.

Adult largemouth bass with clinical LMBVD loose their equilibrium to different degrees, may float at the surface and have swollen abdomens, which are apparently due to enlarged swim bladders. Internally the swim bladder may be inflamed and contain a yellow to yellow-brown mucoid substance. The virus has been found in most southern states from Florida to Texas and north to Oklahoma, Missouri, Indiana and Michigan. Last year it was detected in the Mississippi River between Minnesota and Wisconsin.

Largemouth Bass are the most susceptible but smallmouth, spotted and suwanee are also affected. Black and white crappie, redear sunfish and bluegill have also been found to harbor the virus. Epizootics usually occur between July and September.

Lymphocystis (VM)

Lymphocystis is a viral caused disease of the higher order of fish (Percidae and Centrarchidae). The incidence of the disease in walleye may be high in some locations and affected fish are discarded by fishermen.

The lesions of lymphocystis disease are raised nodular masses of the generally light-colored tissue which resemble warts. The wart like growths

are usually located on the skin or on fins but often may be restricted to a small area of a single fin. The growths are due to viral infected cells enlarging. Color of the lesion is usually light and may be white, gray, or cream colored. There is a tendency toward opalescence, and larger lesions may show pink due to the vascular network. Lymphocystis cells may occur internally, but the infection is characteristically a disease, which involves the skin.

Transmission of the virus is by the bursting and/or sloughing of host cells and release of the viral particles. This can occur intermittently through the duration of the infection, or it can be massive as upon death and decomposition of the host fish. In temperate freshwater fishes, lymphocystis disease usually appears in the spring, peaks in the summer, and disappears through fall and winter.

Northern Pike Herpesvirus (**VN**)

Pike Herpesvirus is an agent associated with and most likely the cause of unusual hypertrophy of some epithelial cells that are embedded in plaques of hyperplastic skin epithelium.

Usually seen in the spring of the year, the skin of northern pike have fait blue spots across the skin. They can be small patches or over the entire surface. Believed to be non pathogenic, it disappears after water temperatures warm.

Infectious Pancreatic Necrosis Virus (**VP**)

Infectious Pancreatic Necrosis is a disease of fry and fingerlings and occasionally of yearling rainbow trout. The virus has also been isolated from nonsalmonid fish and marine invertebrates. Acute infection occurs in 1-4 month old salmonids and can result in cumulative mortality of 100%. Fish six months old or older can undergo subclinical infection and experience no mortality. Survivors can become lifelong carriers of the virus.

Affected fry and fingerlings are darkly pigmented, exhibit exopthalmia and abdominal distension, and trail mucoid pseudocasts from the vent. Infrequently, petechial hemorrhages can occur at the bases of the pectoral and pelvic fins. The behavior of infected fish varies from quiescence with weak respiration to periods of hyperactivity during which fish swim in a corkscrew manner, rotating about their long axis or whirling violently. Internally, the liver and spleen are pale, and the stomach and intestines are devoid of food but filled with a mucoid material. Petechial hemorrhages are evident throughout the pyloric ceca and pancreatic tissues.

Nonsalmonids species that can be infected with IPNv include: menhaden, shad, barbell, bream, common carp, discus fish, eel, goldfish, northern pike, roach, flounder, walleye, zebra danio, white sucker, lamprey, minnow and yellow perch.

Lymphosarcoma (**VS**)

A red sore disease of the pike, *Esox lucius*, has frequently been observed by Minnesota anglers. The disease is specific to northern pike and muskellunge.

The disease is circumpolar in distribution in the northern hemisphere and widely distributed in the USA and Canada. This condition is known to be fatal to muskellunge, but its effect on pike is not totally understood.

Lymphosarcoma is a tumorous condition, which appears as weltlike sores on the flank, fins, or head. The tumor may appear as a cluster of pink blisters, which may rupture, resulting in a sore resembling a lamprey scar. The tumor may also appear as a series of bluish blisters surrounding a “cream-like core”. Or the tumor may most typically appear as what we have traditionally called “red sore”.

Studies to date indicate that the disease is a contact-transmitted virus spread from fish to fish during the spawning act. The disease begins as a skin lesion, which invades the underlying tissues and muscle. Two sequels are then possible: the tumor may progress to involve internal organs and subsequent death of the animal, or the tumor may regress and heal. The highest incidence of the disease is seen in spring, suggesting that the syndrome may cause death of most tumor bearing fish during the summer months.

There is no evidence at this time that this disease affects humans or other animals. However, heavily infected fish are not considered very palatable and are being discarded by most fishermen.

In general, warmwater fish are most susceptible in the spring, although cases have been reported during the winter months. The infection frequently occurs during the winter months, and the disease not showing itself until spring. The best method of control is to avoid the transfer of fish from infected waters to those where the disease has not been know to occur.

Spring Viremia of Carp (**VV**)

Spring Viremia of Carp is a subacute to chronic disease of cultured yearling, sub adult and adult common carp. The virus was first isolated in the former Yugoslavia from carp with clinical signs of erythrodermatitis and infectious dropsy, both of which are bacterial infections. Early in a SVC epizootic, fish are attracted to the water inlet and as the infection advances they become moribund, respire slowly and lie on their side. External signs include darker pigmentation, enlarged abdomen, protruding eyes, inflamed prolapsed anus, and gills are pale with distinct petechiae. Internally, there is severe hemorrhage in the visceral organs.

SVC is caused by the virus Rhabdovirus carpio. SVC only occurred in Europe until it was found in North Carolina at a Koi aquaculture operation and then in Cedar Lake in Wisconsin. Species of fish commonly affected are common, crucian, bighead, silver, and grass carp. Northern pike also can be infected although not with the same clinical signs. Epizootics due to SVC occur at water temperatures of 12 to 22C with an optimum of 16-17C.

MISCELLANEOUS

Open sores/Hemorrhage (SO)

Anytime one sees open sores, furuncles, and fluid filled cysts, the first and most likely cause is bacteria. Primary damage to the epithelial layers may have been due to parasites but now the intrusion is due to bacteria. Bacterial species responsible for such damage may be Aeromonas, Pseudomonas, Citrobacter, or other opportunistic species. Diagnosis cannot be accomplished by the naked eye. Tissues need to be cultured and tissue sections need to be studied to determine the actual identify.

Tumors and Anomalies (TU)

Tumors and malformations of many kinds, some due to injuries, are found among fishes and the cause of many of them is seldom diagnosed. Certain tumors of the liver of hatchery rainbow trout, called hepatomas, are cause by various ingredients in the diet and can be avoided by altering the diet. Viruses are implicated in some tumors. Tumors occur on nearly all organs or tissues. Those on the skin are very obvious and some are spectacular. Most tumors do not appear to be fatal to the fish, and the fishermen can remove them along with the entrails, before the fish is cooked.

The cause of tumors is, for the most part, poorly known. Of course, certain chemicals are known to be carcinogenic and may cause tumors. There is also suspicion that viruses may cause certain tumors, and that is the case with lymphocystis and lymphosarcoma.

But more and more data are accumulating to implicate environmental agents as important for carcinogenesis in humans and other animals, including fish. Many of these agents enter the natural waters and come in contact with fish and invertebrates. These agents, of natural, industrial and agricultural origin, are numerous and include such natural agents as UV light. Other agents include crude oil, various soluble metals and their salts, petroleum wastes, DDT, other pesticides, benzyl, arsenic, domestic wastes, herbicides, aromatic amines, and various components of effluent from mines, industry, and dyestuffs.

The mechanisms by which these environmental agents act to generate neoplasia are presently unknown. That these probably do act additively and

even synergistically in conjunction with multiple host factors is well known in mammalian systems and certainly should be similar in fish.

Spinal Deformities

Spinal deformities are not unusual among fish of various species. Drastic temperature changes during early developmental stages are thought to be responsible in some cases. Diet and contaminants may also be responsible in some instances.

Slime Discoloration

Most slime discoloration is due to either chemicals in the water environment or parasites present on the fish. Trichodina and Ichthyobodo are two ciliated protozoans, which cause excess mucus to build, causing the skin coloration to change. Skin discoloration is a clinical sign of a problem, which can be very valuable to a diagnostician in determining the cause of a problem.

DISEASES OF HATCHERY FISH

PARASITES

SA - Asian Tapeworm - Bothriocephalus acheilognathi
SB - Bass Tapeworm - Proteocephalus
SC - Ceratomyxa shasta
SD - Chilodonella
SE - Diplostomum spathaceum
SF - Myofibrogranuloma
SG - Argulus, fish lice
SH - Heterosporosis
SI - Ichthyopthirius multifiliis, Ich
SK - Proliferative Kidney Disease
SL - Lernea, anchor worm
SM - Bladder worm
SN - Neascus – Black Spot
SR - Ergasilus
SW - Myxobolus cerbralis, Whirling Disease
SY - Gyros
SY - Yellow Grub
SZ - Leeches

FUNGAL INFECTIONS

SM - Branchiomycosis
SP - Saprolegnia

BACTERIA

GILL DISEASES

BC - Flexibacter columnaris, Columnaris
BG - Bacterial Gill Disease, other Flexibacter

INTERNAL

BD - Coldwater Disease, Cytophaga psychropila
BE - Edwarsiella ictaluri, Enteric Septicemia of catfish
BF - Aeromonas salmonicida, common name Furunculosis
BK - Renibacterium salmominarum, Bacterial Kidney Disease
BR - Yersinia ruckeri, Enteric Redmouth

VIRUS

VC - Channel Catfish Virus
VE - Viral Hemorrhagic Septicemia
VH - Infectious Hematopoietic Necrosis Virus
VL - Largemouth Bass Virus

VIRUS (Continued)

VM - Lymphocystis
VN - Northern Pike Herpes Virus
VP - Infectious Pancreatic Necrosis Virus
VS - Lymphosarcoma
VV - Spring Viremia of Carp

MISCELLANEOUS

SO - Open Sores
TU - Tumors
Spinal Deformaties
Slime Discoloration

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