

Management Concerns about Known and Potential Impacts of Lead Use in Shooting and in Fishing Activities

ABSTRACT: We present a summary of the technical review, jointly requested by the American Fisheries Society and The Wildlife Society, addressing the hazards to wildlife resulting from lead objects or fragments introduced into aquatic and terrestrial environments from the use of ammunition and fishing tackle. Impacts from lead are well documented in humans, as well as in terrestrial and aquatic organisms. Concern about impacts from lead ammunition and fishing tackle has resulted in the development of non-lead alternatives, educational campaigns, and regulations to restrict their use. This article discusses the general biological impacts of lead exposure from fishing and shooting activities to fish, wildlife, and humans; summarizes existing and proposed regulations to reduce lead exposure to biota; reviews alternatives to lead materials that are currently available for fishing; and outlines options for further actions to reduce wildlife and human exposure to lead from fishing activities.

**Chris I. Goddard,
Nancy J. Leonard,
Doug L. Stang,
P. Jack Wingate,
Barnett A. Rattner,
J. Christian Franson, and
Steven R. Sheffield**

Previsiones de Manejo Acerca de Impactos Conocidos y Potenciales del Uso de Plomo en Actividades de Caza y Pesca

Goddard is the executive secretary of the Great Lakes Fishery Commission at the Great Lakes Fishery Commission, Ann Arbor, Michigan, and can be contacted at cgoddard@glfc.org. Leonard is an academic specialist at the Center for Systems Integration and Sustainability, Department of Fisheries and Wildlife, Michigan State University, East Lansing. Stang is assistant director at the Bureau of Fisheries, New York State Department of Environmental Conservation, Albany. Wingate is a fisheries research manager who is retired from the Minnesota Department of Natural Resources, St. Paul. Rattner is an ecotoxicologist at the Patuxent Wildlife Research Center, Beltsville Laboratory, U.S. Geological Survey, Beltsville, Maryland. Franson is a research wildlife biologist at the National Wildlife Health Center, U.S. Geological Survey, Madison, Wisconsin. Sheffield is a professor at the Department of Natural Sciences, Bowie State University, Bowie, Maryland and at the National Capital Region—Northern Virginia Center of the College of Natural Resources, Virginia Polytechnic Institute and State University, Falls Church.

RESUMEN: Presentamos un resumen de la opinión técnica solicitada por la Sociedad Americana de Pesquerías y la Sociedad para la Vida Silvestre con respecto a los peligros para la vida silvestre que resultan de la introducción de objetos o fragmentos de plomo a los ambientes acuáticos y terrestres, provenientes del uso de municiones y equipos de pesca. El efecto del plomo está bien documentado en humanos, así como también en organismos terrestres y acuáticos. La preocupación acerca de los efectos de la presencia de plomo proveniente de municiones y equipos de pesca ha resultado en el desarrollo de diseños alternativos libres de plomo, campañas educativas y regulaciones para restringir su uso. En este artículo se discuten los impactos biológicos generales en peces, vida silvestre y humanos de la exposición al plomo derivado de la caza y pesca; se hace un resumen de las regulaciones tendientes a reducir la exposición de la biota al plomo; se hace una revisión de los materiales alternativos al plomo disponibles para las actividades de pesca, y se proponen posteriores acciones tendientes a reducir la exposición humana y de la vida silvestre al plomo producido por las actividades de pesca.

INTRODUCTION

Lead (Pb), being one of the easiest metals to mine and smelt (Pattee and Pain 2003), has been extracted and used by societies for numerous purposes at least as far back in time as the Roman Empire (Hernberg 2000). Lead can be introduced into the environment from multiple sources including surface runoff; atmospheric deposition associated with the burning of coal,

oil, and waste; release of contaminated tailings from mining and smelting activities; the application of products containing lead; and through the loss of lead objects, such as lead shot and fishing weights (IPCS 1989; Henny et al. 1994; Scheuhammer and Norris 1995).

Lead is a nonessential heavy metal with no known beneficial role in biological systems. The adverse effects of lead on human health have long been recognized. Exposure of humans to lead is known to adversely

affect hematopoiesis, the central and peripheral nervous systems, the renal system, cardiovascular system, and can result in brain dysfunction, neuropathy, altered amino acid transport, anemia, impaired fetal development, and reduced survival (Nordic Council of Ministers 2003; Khan 2005). Some studies have associated elevated bone or blood lead levels with aggression, delinquent behavior (Needleman 2004), and attention deficit hyperactivity disorder (Braun et al. 2006). Although the adverse effects of lead on human health have long been recognized, the exposure of fish, wildlife, and humans to lead continues (Hernberg 2000).

In comparison to the long-standing recognition of the effects of lead poisoning in humans, the hazard of lead ammunition and fishing sinkers to wildlife has only recently been acknowledged (Pattee and Pain 2003). In this article we present a summary of the technical review that was jointly requested by the American Fisheries Society and The Wildlife Society (Rattner et al. 2008). Specifically, we review briefly the effects of lead introduced by fishing and shooting activities to living organisms, discuss regulations and alternatives to lead to reduce exposure, and suggest possible actions that may further minimize lead introductions into the environment from fishing.

DISSOLUTION OF LEAD FROM SPENT AMMUNITION AND FISHING TACKLE

Spent lead ammunition and lost lead fishing tackle are not readily dissolved in aquatic and terrestrial systems and, depending on environmental conditions, can be relatively stable and remain intact for decades to centuries (SAAMI 1996). Lead from spent ammunition and tackle can undergo weathering and lead salts can dissociate, form stable complexes (carbonates, hydrides, chlorides), precipitate (phosphates, sulfides, carbonates, hydroxides), become bound to soil and sediments, and thus exist in many forms with varying degrees of bioavailability. Uptake of lead by plants is relatively limited, although several studies have documented elevated lead concentrations in plants in the vicinity of shooting ranges (Rooney et al. 1999; Hui 2002; Cao et al. 2003; also reviewed in Rattner et al. 2008). Weathering and dissolution of elemental lead is influenced by water chemistry, mechanical distur-

bance (e.g., water flow rate), grain size of soils and sediments, gaseous aerobic conditions, and acidity and alkalinity. Under some conditions (e.g., soft acidic waters, mechanical disturbance), lead can be released from artifacts, although annual corrosion rates of lead are generally low (Jacks and Bystrom 1995). Due to the possible dissolution of lead ammunition and fishing tackle, we review briefly the findings from studies examining the effects of bioavailable lead on living organisms, including fish, amphibians, reptiles, birds, mammals, and humans.

In field and laboratory studies, lead is generally found to evoke its toxicity in multiple organ systems. Perhaps best known are inhibition of heme-synthesis enzymes, lead-induced anemia, central and peripheral neuropathy, nephrotoxicity, hypertension, and alteration to endocrine and reproductive function. Lead is also known to be a carcinogen for some animals (Needleman 2004). Numerous studies have examined the effects of lead on fish. It is well known that bioavailable lead principally accumulates in the gills, liver, kidney, and bone; can evoke morphological lesions (e.g., erosion of caudal fin, spinal deformities); alters physiological function (e.g., enzyme inhibition, anemia, decreased survival); and impairs avoidance behavior (IPCS 1989). The report compiled by International Programme on Chemical Safety (IPCS 1989) also summarized studies on effects of lead on amphibians, which include arrested development and delayed hatching. Similarly, while their review was not focused solely on lead sources linked directly to hunting and fishing activities, Pattee and Pain (2003) considered the literature about lead in the environment and identified many existing studies pertinent to this focus on lead exposures. For example, studies in the Coeur d'Alene floodplain, which is heavily contaminated by heavy metals such as arsenic, lead, and zinc from mining and smelting activities, have also detected negative effects from the accidental ingestion of lead-contaminated food or the accidental ingestion of lead associated with sediments in osprey (*Pandion haliaetus*), raptors, songbirds, and tundra swan (*Cygnus columbianus*; Henny 2003). These negative effects included inhibition of delta-aminolevulinic acid dehydratase involved in heme synthesis, elevated lead levels in blood and tissues, and weight loss. In addition, waterfowl

die-offs have been reported from this area since the early 1900s. Humans exposed to lead have experienced similar negative effects to those described for fish and wildlife.

Due to their intended scope, the aforementioned studies do not investigate the effects of bioavailable lead from spent ammunition or from lost fishing tackle. Lead objects can dissolve under certain conditions, thereby contaminating soil, sediment, and vegetation, and resulting in exposure of biota via ingestion of soil, sediment, food, and water. Nevertheless, for bioavailable lead arising from ammunition and fishing tackle to have significant effects on biota at the organism- or population-level, the quantity of shot or tackle lost within a given area would have to be substantial.

LEAD EXPOSURE RELATED TO SHOOTING ACTIVITIES

The effects of spent lead shot and bullets on American wildlife has been recognized since the 1870s (Sanderson and Bellrose 1986), but it wasn't until the 1959 publication by Bellrose, "Lead poisoning as a mortality factor in waterfowl populations," that the widespread hazard of spent lead shot was fully appreciated. The availability of spent lead in a terrestrial setting is a function of the depth these particulates are located in soil or sediment. Several investigations have demonstrated that shot accumulates in most sediment near the surface and, thus, the total number of shot available can increase in density and availability over time (Pain 1992). In an aquatic setting, spent lead shot availability is affected by water depth and the depth that the shot is buried within the sediment. With the popularity of sport shooting (target, trap, and skeet shooting) and firearms training in the United States and elsewhere, an estimated 72,600,000 kg per year of lead is deposited at 9,000 shooting ranges (USEPA 2001). The amount of lead shot deposited in waterfowl hunting areas has been estimated to range from 125,970 to 5,000,000 shot per hectare (Bellrose 1959; Pain 1992, respectively). It is generally accepted that shot density in a field or wetland is directly related to hunting or shooting intensity.

Documentation of fish ingesting spent lead bullets or shot was not found. Also, evidence was not found that ingestion of

lead shot and lead bullets by amphibians or reptiles is a widespread problem, and there is limited information documenting the incidence of lead shot, bullets, fragments, or fishing sinkers in the digestive system of these vertebrates. Lance et al. (2006) reported reproductive failure in captive American alligator (*Alligator mississippiensis*) that was potentially associated with lead exposure. These alligators were fed wild nutria (*Myocastor coypus*) meat contaminated with lead shot, and the alligators' eggs' yolk had a high lead concentration (Lance et al. 2006). Ingestion of lead shot was also observed in other farmed American alligators (Camus et al. 1998) and Australian crocodiles (*Crocodylus porosus*; Hammerton et al. 2003). In general, studies with sites in close proximity to shooting ranges have found elevated concentrations of lead in the tissues of amphibians and reptiles, which is thought to be due to ingestion of lead with water and food items (Pattee and Pain 2003).

Birds can ingest spent bullets, shot, or their fragments. Ingestion most likely occurs due to the bird mistaking these lead artifacts for food or grit material (Sanderson and Bellrose 1986; Scheuhammer and Norris 1995). Waterfowl have been documented to die from ingesting lead shotgun pellets deposited on the bottom of lakes, in marshes, and in fields. Often cited reviews addressing the effects of ingested shot on waterfowl include Bellrose (1959) and Sanderson and Bellrose (1986). Waterfowl may succumb after ingesting one or more lead pellets, as their bodies waste away over a period of several weeks—losing from 30 to 50% of their normal weight. Less frequently, a large number of shot are ingested, resulting in an acute form of lead poisoning, and the bird dies even though it still has a normal weight. In addition, the risk of spent shot to other upland species, including dove and quail, has long been recognized (Kendall et al. 1996). Raptors and other avian predators, as well as scavengers, may be exposed to lead from the consumption of shot pellets and bullet fragments embedded in tissues of dead or wounded animals (Pattee and Pain 2003) or from tissues discarded in gut piles (Fisher et al. 2006). For instance, vultures and condors appear highly susceptible to toxicity from ingesting small quantities of lead shot or bullets, as they are unable to regurgitate pellets from their gastrointestinal tracts (Eisler 1988). The presence

of lead in California condor (*Gymnogyps californianus*) habitats in California and Arizona, in conjunction with their extreme sensitivity to lead toxicity, has been suggested as the primary threat to the continued existence of the species (Pattee et al. 1990; Meretsky et al. 2000). Recent evidence indicates that lead ammunition embedded in carcasses of hunted game and mammalian predators (coyotes, *Canis latrans*) or gut piles are the main sources of the lead accumulated by California condors (Church et al. 2006).

Ingestion of lead shot and bullets by humans, or the associated dust when casting ammunition has received considerable attention (reviewed by CPSB 2002). There are numerous case reports of accidental or purposeful (pica) ingestion of lead shot by humans in the medical literature (Gustavsson and Gerhardsson 2005). Ingestion of lead shot and bullets can cause lead intoxication, and depending on number and mass of fragments, lead lodged in certain but not all tissues can result in toxicity (Khan 2005). Accidental ingestion of ammunition by children has been documented (Durbach et al. 1989). Furthermore, many sportsmen reloading rifle and pistol ammunition cast their own lead bullets, an activity particularly popular with black powder shooters, which exposes them to lead (Anonymous 2006).

The hazard that ingestion of lead pellets and bullets might pose to higher vertebrates is acknowledged, and in some instances already vulnerable populations (e.g., California condor) may become further at risk.

FISHING ACTIVITIES AND LEAD

Lead in the form of fishing lures, sinkers, lead core fishing line, downrigger cannonballs, and weights on a wide variety of fishing traps and nets can be introduced into the aquatic environment when a commercial fisher or recreational angler loses fishing gear due to accidental or intentional breakage. The amount of lead fishing tackle lost in the aquatic environment through recreational and commercial fishing activity is not accurately known. In studies based on angler interviews and actual detection of lost tackle along shorelines, the reported amount of lead fishing tackle lost varies, depending on the intensity of fishing pressure, the location

of angling activity such as distance from the shoreline or boat, the type of aquatic habitat that may increase gear breakage and loss, and angler skill. Based on interviews, Radomski et al. (2006) reported average loss rates of 0.0127 lures per hour, 0.0081 large sinkers per hour, 0.0057 split shot sinkers per hour, 0.0247 jigs per hour, and 0.0257 hooks per hour; while Duerr (1999), assessing the amount of lead fishing tackle lost and detected along shorelines, estimated that there was from 0.0 to 0.01 sinkers per square meter in areas of low angling pressure and 0.47 sinkers per square meter in areas of high angling pressure. Some reports suggest that loss of lead fishing tackle in the aquatic environment can be substantial (e.g., Scheuhammer and Norris 1995).

Fish most frequently ingest, partially or wholly, fishing tackle when hooked. Whether the fishing tackle remains in the fish depends on whether the angler successfully lands the fish and whether the hook is too deeply ingested to safely remove it from the fish. The abandonment of fish hooks and associated fishing tackle may arise due to an angler breaking the line with a fish on, or leaving deeply set hooks in the fish to reduce injury (Cooke et al. 2001). Most reported mortality associated with fishing tackle is not related to the fish being exposed to the lead material used in the fishing tackle, but rather due to the extent of injury, blood loss, exposure to air, and exhaustion during handling to remove the hook (Cooke et al. 2001). Studies that related lead exposure from ingested lead sinkers and jigs or other tackle to the mortality of fish were not found. Nevertheless, given that it is commonly accepted that hooks and leaded jigs embedded in the mouths of fish will work their way loose, the effects of the lead from embedded fishing hooks and jigs would be minimal, in comparison to the potential sub-lethal and lethal injuries that may occur from swallowed hooks.

Evidence was not found that ingestion of lead fishing tackle by amphibians or reptiles is a widespread problem. There are published and unpublished accounts, however, of turtles suffering from lead poisoning after ingesting lead fishing weights (Borkowski 1997).

Concern about lead poisoning in birds from anglers' lead weights emerged as a significant issue during the 1970s as mute swan (*Cygnus olor*) populations declined

in Britain (Sears 1988). This eventually resulted in the banning of most lead fishing sinkers in the United Kingdom in 1986 (Pattee and Pain 2003). In North America, the hazard of fishing sinkers and tackle to common loons (*Gavia immer*) was subsequently reported (Franson and Ciplef 1992; Pokras and Chafel 1992; Stone and Okoniewski 2001). Necropsy of common loons examined in New England found that lead poisoning from ingested fishing sinkers accounted for about one-half of the mortality in dead and moribund adults found during the breeding season (Pokras and Chafel 1992; Sidor et al. 2003). Birds most frequently ingest fishing tackle that has been lost or abandoned by anglers along the banks or within water-bodies. In their review, Scheuhammer and Norris (1995) stated that birds generally ingest lead fishing weights that are less than 57 grams (2 ounces), although ingestion of larger sinkers has been documented in the common loon (Franson et al. 2003). Thus, the harm from fishing weights to waterbirds seems to primarily involve smaller lead fishing weights used by recreational anglers (Scheuhammer and Norris 1995) and not larger weights or downrigger can-


nonballs. Based on the recovery of fishing weights associated with other fishing tackle (i.e., swivels and hooks), some birds such as the common loon may be ingesting lead fishing weights as a byproduct of ingesting the bait attached to the fishing tackle (Franson and Ciplef 1992; Stone and Okoniewski 2001). Once ingested by a bird, the lead object, if retained within the gizzard, will be ground down and, combined with the effect of the acidic conditions in the digestive tract, result in the lead being released and absorbed into the bird's tissues (IPCS 1989; Scheuhammer and Norris 1995; Nordic Council of Ministers 2003). It has been reported that lead fishing sinkers and jigs have contributed to lead poisoning mortalities in a number of aquatic birds, particularly mute swans, whooper swans (*Cygnus cygnus*), Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos*), brown pelicans (*Pelecanus occidentalis*), and common loons (Franson and Ciplef 1992; Pokras and Chafel 1992; Scheuhammer and Norris 1995; Stone and Okoniewski 2001; Franson et al. 2003). If the bird has the lead object embedded subcutaneously or intramuscularly, lead poisoning should not occur as the pH con-

ditions in these tissues do not dissolve lead objects (De Francisco et al. 2003). There is the risk, however, of secondary poisoning by lead fishing weights for waterfowl predators, but studies linking lead poisoning of predators due to ingestion of a lead fishing weight lodged in their prey were not found in the literature.


Ingestion of lead sinkers or the dust associated with their manufacturing has been known to cause harm in humans. In sinker ingestion, the occurrence of lead toxicity depends on the amount of time that the object is retained within the stomach (Fergusson et al. 1997). If the lead object is retained in the stomach long enough for the object to be dissolved by the stomach acid, the lead will be absorbed while it is in the small intestine (Fergusson et al. 1997). Once the lead object is out of the stomach and in the small intestine it poses less of a potential hazard for lead toxicity (Fergusson et al. 1997). The U.S. Environmental Protection Agency (USEPA 1994) estimated that approximately 0.8 to 1.6 million people manufacture lead fishing weights in their homes for either personal use or for sale, representing approximately

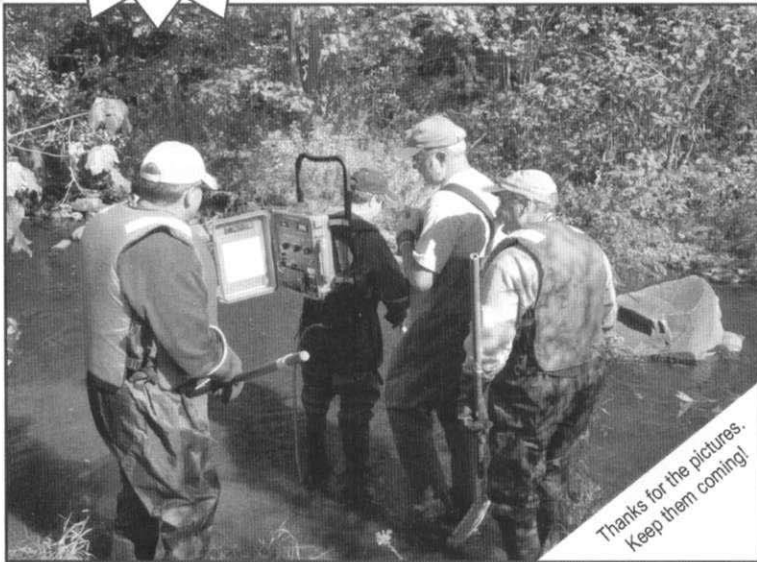
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30 to 35% of lead sinkers produced in the United States. Scheuhammer and Norris (1995) speculated that there is likely a similar "cottage industry" in Canada. Thus, the cottage-industry of melting lead and producing lead fishing tackle such as lead sinkers and jigs is a potential source of lead poisoning in humans through lead inhalation (USEPA 2004).

Lead fishing tackle, especially the smaller fishing weights and jigs that can be ingested, may be a source of lead poisoning for some species of waterbirds and can exert sub-lethal and lethal effects in the individual. Although of concern where waterbird populations are low or declining, the ingestion of lead sinkers has not been demonstrated to have wide-spread population-level effects. Nevertheless, the potential hazardous effect of lead on humans and aquatic ecosystem fauna lends support to an ongoing, general effort to reduce lead introduced into the environment by human activities.

ACTIONS TO REDUCE LEAD EXPOSURE

The desire to limit lead exposure in humans has resulted in several international conventions and treaties, as well as national restrictions to minimize environmental release of lead from anthropogenic activities including use of leaded gasoline, lead in paint, lead solder in tin cans for food storage, and lead shotgun pellets (Nordic Council of Ministers 2003). Scheuhammer and Norris (1995) provide a brief overview of restrictions placed by nations that are specific to the use of lead shot. These restrictions range from voluntary use of non-toxic shot for all wetland bird hunting in the United Kingdom, to nationwide restrictions on hunting migratory waterfowl species with lead shot in Canada and the United States, to an outright ban on the use of lead shot for all hunting and target shooting over water and agricultural lands in Denmark. A more recent example of this effort is the passing of the 2007 California Assembly Bill 821 "Ridley-Tree Condor

Preservation Act" that requires the use of non-lead ammunition for hunting big game and coyotes in the range of the California condor in central and southern California (Center for Biological Diversity 2007).

The hazard of ingested lead fishing weights on aquatic and terrestrial fauna and humans has resulted in societal pressure to place restrictions on the sale and use of lead fishing weights. For instance, some nations, including Denmark, Canada, Great Britain, and the United States (partially summarized by Nordic Council of Ministers 2003), have begun to apply restrictions on the sale and use of lead fishing sinkers and jigs. In Canada the use of lead sinkers or jigs weighing less than 50 grams (1.76 ounces) in national parks and national wildlife areas is prohibited (Michael 2006). The use of lead tackle is also banned on some U.S. federal lands that have loon and swan populations (Michael 2006). In 1999, the U.S. Fish and Wildlife Service announced its intent to establish additional lead-free fishing areas by expanding the prohibition on certain fishing sinkers and jigs to more refuges used by loons (USFWS 1999); however, this has yet to be implemented. Some states, consisting of Maine, Massachusetts, New Hampshire, Vermont, and New York have, nonethe-

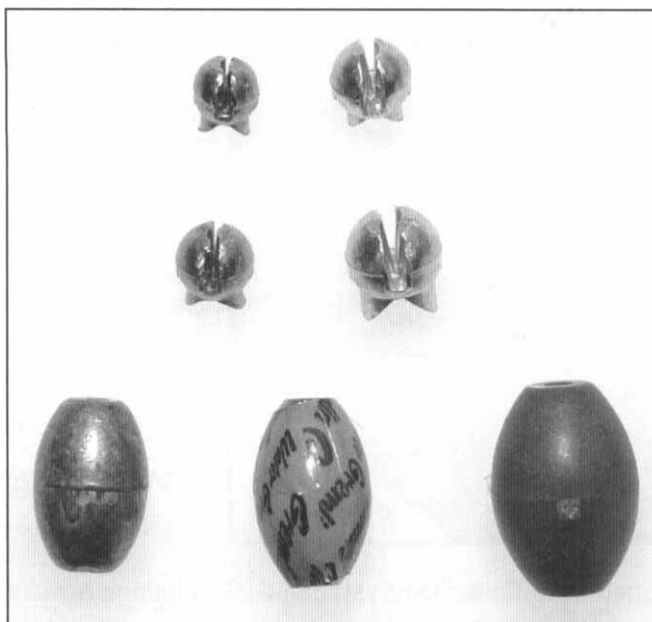
less, instituted restrictions on the use or sale of certain lead sinkers and jig heads (Michael 2006).

There are alternatives to lead bullets (e.g., copper; Barnes 2008) and to lead shot available to hunters. Alternatives to lead shot that have been approved for use in hunting waterfowl and coots and that are commercially available include shot made from steel, bismuth-tin, tungsten-bronze, tungsten-iron, tungsten-matrix, tungsten-nickel-iron, tungsten-polymer, tungsten-tin-bismuth, and tungsten-tin-iron-nickel. Substitutes for lead fishing tackle also have been available in retail stores in Canada, the United States, and European countries for several years (Scheuhammer and Norris 1995; Nordic Council of Ministers 2003). These include tungsten (both plastic composites and putty), stainless steel, carbon steel, tin, tin-bismuth, brass, ceramics, glass, and pewter (Scheuhammer and Norris 1995; Nordic Council of Ministers 2003; MOEA 2006). Sinkers made from alternative materials have been accepted to varying degrees, depending on their cost and how similar they are to lead tackle. Several of these alternatives such as ceramics and tin are not as dense as lead and, hence, need to be larger to produce the same weight (see Figure 1). Many

anglers believe this increase in size is detrimental when inducing fish to bite. Other alternatives such as brass and steel, while somewhat larger in size, have been advertised as making more noise as they bump over the bottom, which is claimed to serve as an attractant to fish.

It needs to be stated, however, that a transition to alternative materials for sinkers provides significant challenges to the tackle manufacturing industry in terms of increased cost, availability of raw materials, and increased manufacturing costs, as well as the increased cost to anglers. The high cost of alternative raw materials may make the transition to non-lead sinkers more problematic now than several years ago. For example, tin is perhaps the most viable alternative for split shot sinkers and the manufacturing costs are

Figure 1. Relative sizes of sinkers manufactured from different materials. Top row: 0.1 oz lead and tin split shot. Middle row: 0.2 oz lead and tin split shot. Bottom row: 0.8 oz lead, bismuth, and plastic-iron composite egg sinkers. Sinkers courtesy of Water Gremlin.



similar to lead. The December 2007 price differential for the raw materials, however, is approximately \$7.42 per pound for tin versus \$1.15 for lead (MetalPrices.com 2007). As the specific gravity of tin is 7.2 versus 11.3 for lead, more tin is required to provide the same weight. Tin, therefore, is not only more costly, but also has performance drawbacks. Bismuth and tungsten currently cost \$15/lb and \$20/lb respectively. Moreover, tungsten is becoming essentially unavailable and has a high manufacturing cost. Brass may prove to be a less desirable alternative, because brass contains approximately 9% lead, as well as some zinc which could be problematic. Sintered steel, an alternative for non-split shot sinkers, has a specific gravity of less than 7 and it tends to rust in the tackle box. Although a variety of alternatives to lead sinkers have been proposed and investigated by the manufacturers of fishing tackle, it is not clear which alternatives will provide reasonable performance at reasonable cost.

As part of the effort to reduce the use of lead in fishing activities, some U.S. states, Environment Canada, and some U.S. and Canadian organizations

are offering small-scale programs that exchange non-lead tackle for an angler's lead tackle (MOEA 2006). Educational campaigns also introduce anglers to non-lead substitutes and alert anglers to the toxicity of lead in the aquatic environment, with the aim of increasing angler use of non-toxic alternatives.

SUMMARY

The effects of ingested lead shot and bullets used in hunting and shooting sports activities are well documented. Principally, these include lead toxicosis and mortality of waterfowl and their predators (Pattee and Pain 2003). These impacts have resulted in restrictions on the use of lead shot and bullets, and subsequently regulations mandating the use of various non-toxic shot for species with habitats that coincide with waterfowl and condors. Studies assessing sub-lethal and lethal effects from lead shot ingestion among other wildlife, such as upland birds, are being conducted and discussions regarding the implications of lead toxicosis are ongoing among managers and policy makers (e.g. Association

of Fish and Wildlife Agencies' Non-toxic Ammunition Task Force and its Ad Hoc Mourning Dove and Lead Toxicosis Working Group).

Fishing tackle, especially weights that fall within the size usually ingested by fauna (e.g., less than 2.5 cm, 0.98 inches) and weighing less than 50 g (1.76 ounces; Scheuhammer and Norris 1995), can have lethal and sub-lethal effects on aquatic fauna and on humans when ingested. Downrigger weights (cannonballs), lead core fishing line, and the weights used on a variety of commercial traps and nets are much larger than fishing sinkers and smaller jigs that have been ingested by fauna in aquatic ecosystem and by humans. Therefore, one would predict that the effect normally associated with ingestion of lead fishing tackle is minimal for downrigger cannonballs, lead core fishing line, and the weights affixed to commercial fishing gear. Some studies have examined the dissolution of lead from fishing tackle, although these are few and not conclusive. More research needs to be conducted to determine the potential effect on fauna of the dissolution of all types of lead fishing tackle in

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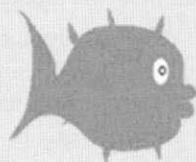
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low and high deposition densities and varying water chemistry conditions.

RECOMMENDATIONS

As stewards of North America's aquatic ecosystems, fisheries management agencies, anglers, angling clubs, and commercial fishers, as well as manufacturers and retailers of fishing tackle, work actively and often collectively for the protection and conservation of North America's aquatic ecosystems. A tenet of this stewardship is minimizing the introduction of toxic materials, such as lead, to levels that have been shown to be non-hazardous, while recognizing that complete elimination may be neither feasible nor necessary. Detrimental effects at the population level of bird species that ingest lead sinkers have not been documented in North America, but impacts at the population level should not be a prerequisite for corrective action. Current knowledge indicates that small lead (and other toxic) sinkers (< 2.5 cm), in particular, are most likely to be ingested by waterbirds. Several options exist for the American Fisheries Society (AFS), perhaps through a small task group, to develop a position statement (white paper) based on the scientific data on the hazard and risk of lead from lost commercial and recreational fishing tackle.

1. The AFS could work with the provincial, state, and federal fisheries management agencies, in addition to the angling clubs, tackle manufacturers, and tackle retailers to educate anglers and commercial fishers about the availability and utility of non-toxic alternatives to lead weights and the environmental benefits of using these alternatives. AFS could also work with the U.S. National Institute of Health and Health Canada to educate anglers about the potential health hazards of casting and manufacturing their own lead sinkers and jigs.
2. The AFS Fisheries Management and Fisheries Administration Sections could collaborate to develop a specific Aquatic Resources Conservation Electronic Library (ARCeL) module for use as part of a lead-free education/outreach project, perhaps funded by the Fisheries Conservation Foundation. All of the requisite educational materials

could be made available for production and distribution by all management agencies, fishing tackle manufacturers, and retailers.

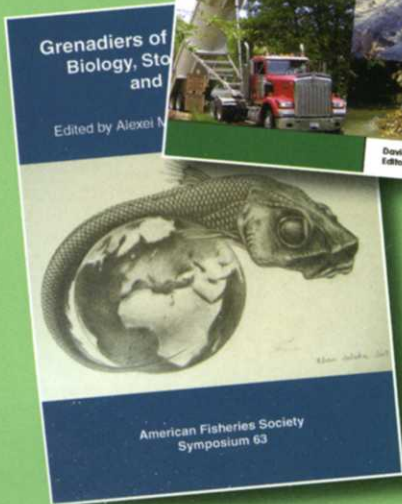
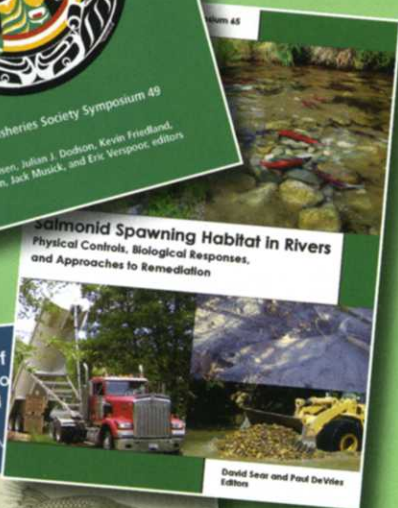
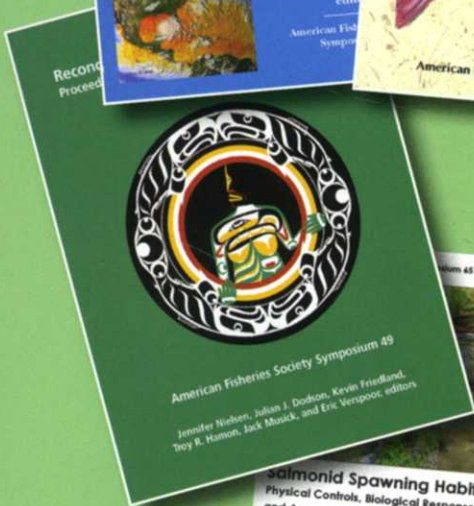
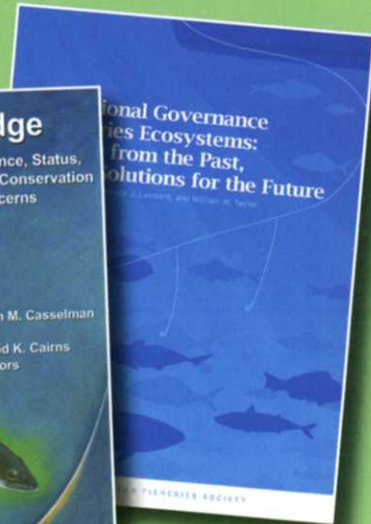
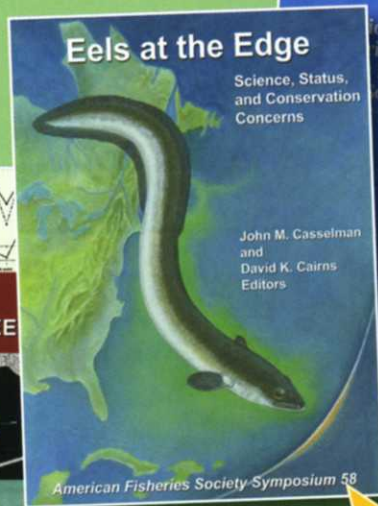
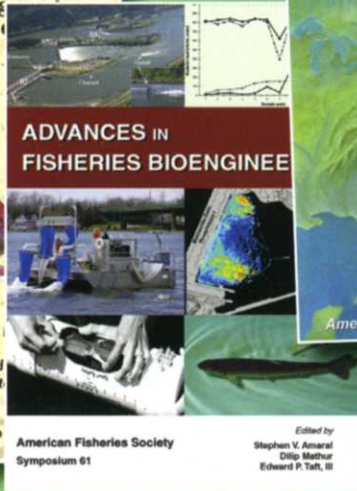
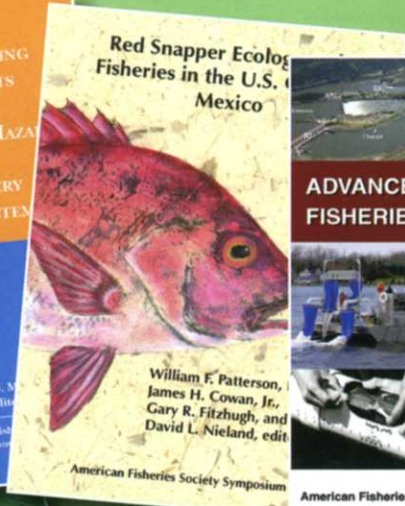
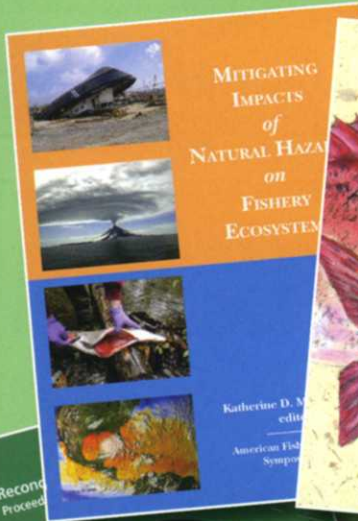
3. AFS could partner with and encourage fisheries management agencies to develop lead tackle exchange programs and, in conjunction with this tackle exchange effort, participate in safe collection and disposal programs for lead fishing tackle.
4. AFS could work closely with the Association of Fish and Wildlife Agencies (AFWA), fishing tackle manufacturers, the American Sportfishing Association (ASA), and the Canadian Sportfishing Industry Association (CSIA) to encourage and facilitate a transition from the manufacture, distribution, and sale of small lead fishing weights to fishing weights made of non-toxic alternative materials. The development of schedules would facilitate this transition. It is recognized that a number of the recreational and commercial fishing tackle manufacturers have already taken the initiative by entering into the lead-free tackle market, and are well into this transition; however, the shelf space and volume of alternate material weights remains a small percentage of the overall inventory and sale of these small fishing weights
5. Consistent with the above negotiated transition schedule for the manufacture and sale of alternatives to lead, the AFS could work with the AFWA, ASA, and CSIA to develop a framework for future phased-in regulations on the sale, use, and possession of lead fishing sinkers while fishing. This framework would provide for requisite consistency in the rules, regulations, and their implementation; would help deliver a strong message to anglers; and would allow manufacturers to more easily develop and market non-lead products.
6. The AFS may consider local bans on the use of lead fishing sinkers as an appropriate management tactic in geographical areas of high annual mortality of waterbirds associated with lead poisoning and in heavily protected pristine areas such as national parks and national wildlife refuges.

In conclusion, AFS interacts with many natural resource management agencies, angling organizations, and the fishing tackle industry. AFS, therefore, is in a position to both foster education on the hazards of lead to wildlife and to develop a position statement with the aim of reducing to an absolute minimum the introduction of lead into the aquatic environment from fishing activities.

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Publications Catalog 2008



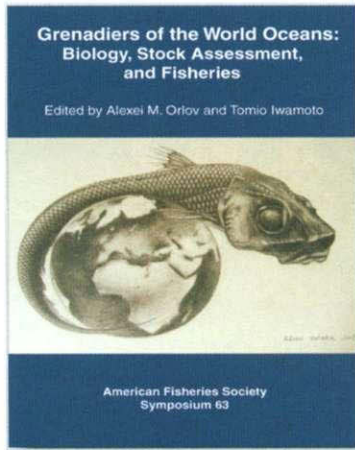
CONTENTS

NEW RELEASES	2
AQUACULTURE	5
BIOLOGY	5
ECOLOGY	6
EDUCATIONAL & PROFESSIONAL TOOLS	7
GUIDES & FAUNA	8
HABITAT	9
INVERTEBRATES	10
MANAGEMENT	11
METHODS	13
JOURNALS & MAGAZINE SUBSCRIPTIONS	14
ORDER FORM	15
INDEX	BACK COVER

The American Fisheries Society (AFS) is an international, professional, and scientific organization of nearly 9,000 fisheries managers and aquatic scientists. Founded in 1870, AFS is the world's oldest and largest organization dedicated to strengthening the fisheries profession, advancing fisheries science, and conserving fisheries resources. Chapters of AFS exist throughout North America and members reside in 67 countries.

NEW RELEASES

GUIDES AND FAUNA



Grenadiers of the World Oceans: Biology, Stock Assessment, and Fisheries

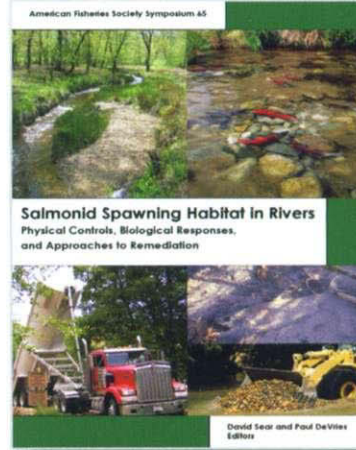
Alexei M. Orlov and Tomio Iwamoto, eds.

Grenadiers or rattails are widely distributed in the oceans from the Arctic to the Antarctic. This is the first book to examine different aspects of the distribution, ecology, life history, stock assessment, and fisheries of different grenadier species in the oceans. The 25 chapters, written by 65 international experts, provide the most current data on the biology and fisheries of grenadiers. This volume will appeal to a wide spectrum of professionals, including fisheries scientists and managers, marine biologists and ecologists, and oceanographers.

(SY 63), 484 pp, paper, 2008
 ISBN-13 978-1-934874-00-4
 stock 540.63P
 list price \$69
 member price \$48

NEW RELEASE

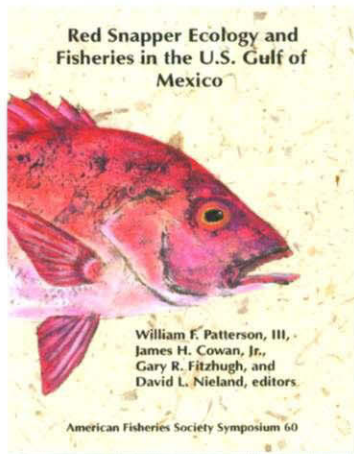
HABITAT



Salmonid Spawning Habitat in Rivers: Physical Controls, Biological Responses, and Approaches to Remediation

This timely volume presents recent research on the interactions between physical habitat and the ecology of salmon. Salmon habitats have been under increasing pressure from catchment management and river management activity, resulting in a decline in available habitat. North American and European scientists review the processes controlling habitat availability, explore the issues impacting the quality of this habitat, and assess the biological factors affecting habitat use and the interaction between habitat quality and salmon reproductive success.

(SY 65), 370 pp est., paper, 2008
 ISBN-13 978-1-934874-03-5
 stock 540.61P
 list price \$69
 member price \$48



Red Snapper Ecology and Fisheries in the U.S. Gulf of Mexico

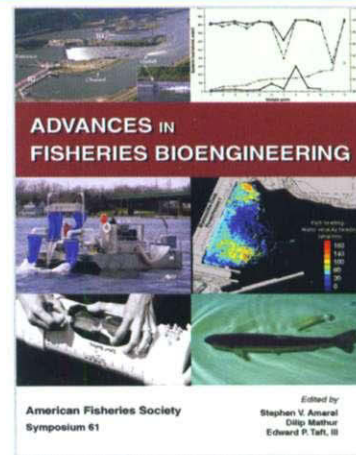
William F. Patterson, III, James H. Cowan, Jr., Gary R. Fitzhugh, and David L. Nieland, eds.

Red snapper is among the most ecologically and economically important reef fishes in the northern Gulf of Mexico. Fisheries management for the species also happens to be among the most controversial in the U.S. Gulf red snapper has been estimated to be overfished and undergoing overfishing since at least the late 1980s. Management is complicated, however, because the greatest source of mortality for red snapper is believed to come from shrimp trawl bycatch, not the directed fisheries. Despite all efforts to solve the bycatch problem and otherwise recover red snapper, the stock remains significantly overfished. This volume provides the state of knowledge for research on red snapper ecology and fisheries.

(SY 60), 396 pp, paper, 2008
 ISBN-13 978-1-888569-97-1
 stock 540.60P
 list price \$69
 member price \$48

NEW RELEASES

MANAGEMENT

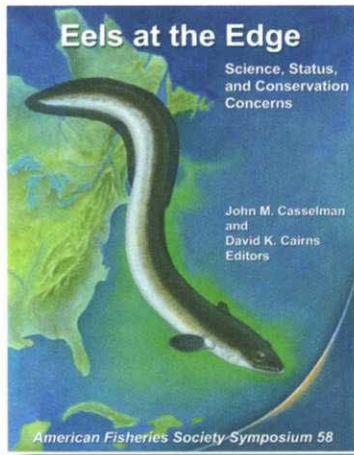


Advances in Fisheries Bioengineering

Stephen V. Amaral, Dilip Mathur, and Edward P. Taft, III, eds.

Authors who are leaders in their field examine a wide range of new research associated with fish passage (upstream and downstream), water intake fish protection technologies, sampling technologies, and techniques for assessing fishway performance and migration behaviors, aquaculture, and habitat restoration and enhancement.

(SY 61), 239 pp, paper, 2008
 ISBN-13 978-1-934874-02-8
 stock 540.61P
 list price \$69
 member price \$48

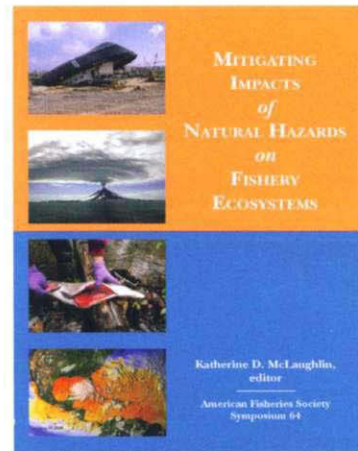


Eels at the Edge: Science, Status, and Conservation Concerns

John M. Casselman and David K. Cairns, eds.

There is a catastrophic worldwide decline of anguillid (freshwater eel) species. World authorities on the three species consider mechanisms for addressing this concern and reversing trends. This book emphasizes recent and new insights into basic biology, resource status, and management procedures. Chapter authors provide innovative approaches to stock assessment and management.

(SY 58), 400 pp est., hardcover, 2008
 ISBN-13..... 978-1-888569-96-4
 stock.....540.58C
 list price.....\$69
 member price.....\$48

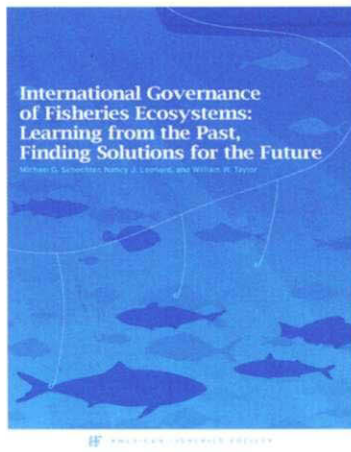


Mitigating Impacts of Natural Hazards on Fishery Ecosystems

Katherine D. McLaughlin, ed.

The inevitability of natural hazards makes them a topic of relevance to a wide range of scientists. From regional fisheries managers to policy makers, hazards, be they atmospheric, hydrologic, or geologic, affect all aspects of fisheries and all geographies. In this volume, authors discuss not only the impact of natural hazards on fish populations, but also the effect on the fishery habitat and the fishing and coastal communities dependent on such populations. Research on an assortment of hazards is presented, including earthquakes, volcanoes, hurricanes, tsunamis, hypoxia, and harmful algal blooms.

(SY 64), 444 pp, hardcover, 2008
 ISBN-13..... 978-1-934874-01-1
 stock.....540.64C
 list price.....\$60
 member price.....\$42



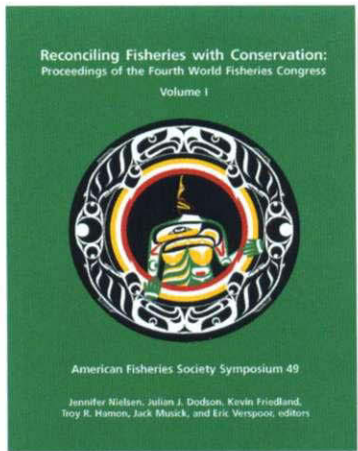
International Governance of Fisheries Ecosystems: Learning from the Past, Finding Solutions for the Future

Michael G. Schechter, Nancy J. Leonard, and William W. Taylor, eds.

Fisheries experts increasingly acknowledge the importance of globalization on local, national, and international fisheries. This book brings together fisheries and governance experts from across the globe who present case studies on a broad spectrum of the internationally shared fisheries that inhabit diverse freshwater and marine ecosystem types.

Case studies provide the biological background of the fisheries resource, including status and threats to the resource and its ecosystem. The case studies review the evolution and current governance institutions of the fisheries resource, with particular focus on international or global institutions. Each study concludes with an evaluation of the effectiveness of the current fisheries governance institutions, and recommendations for changes.

450 pp est., paper, 2008
 ISBN-13..... 978-1-888569-99-5
 stock.....550.56P
 list price.....\$69
 member price.....\$48



Reconciling Fisheries with Conservation: Proceedings of the Fourth World Fisheries Congress

Jennifer Nielsen, Julian J. Dodson, Kevin Friedland, Troy R. Hamon, Jack Musick, and Eric Verspooor, eds.

Across the globe, in developed and developing countries, the conflict is clear. Economic and social issues involving fish and fisheries are at odds with conservation and sustainability. This book examines key questions covering the range of global fisheries issues in a diversity of aquatic ecosystems:

- What should we care about when attempting to reconcile fisheries with conservation?
- Who owns the fish and what are they worth to society?
- Can we get more fish or benefits from fish and still reconcile fisheries with conservation?
- How can we manage aquatic ecosystems to reconcile fisheries with conservation?
- How do we reconcile fisheries with conservation in marine waters?
- How do we reconcile fisheries with conservation in freshwater habitats?

(SY 49), 1,946 pp, 2 volumes, paper, 2008

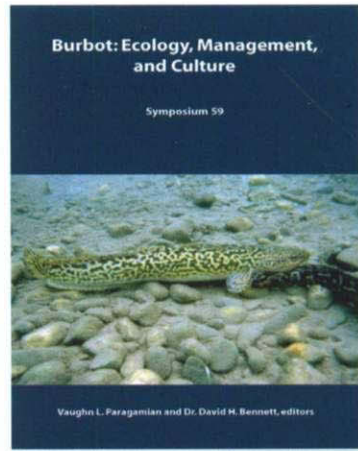
ISBN-10 1-888569-80-8

ISBN13 978-1-888569-80-3

stock 540.49P

list price \$75

member price \$53



Burbot: Ecology, Management, and Culture

Vaughn L. Paragamian and David H. Bennett, eds.

Burbot are circumpolar in distribution and found in the northern tier of states and Canada. Burbot populations are threatened or have been extirpated in many waters in their southern range in North America. The status of burbot is in question in some European countries, or they have been extirpated in others.

Among other topics, this volume explores differences in mitochondrial DNA frequencies of burbot in the Pacific Northwest, how temperature changes due to regulated discharge from a dam and climatic changes may be affecting burbot abundance, the status of burbot in the Great Lakes, burbot culture, and how local government and a Native American tribe intervened to develop a burbot conservation strategy.

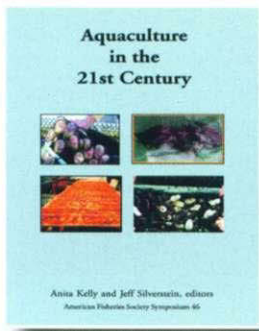
(SY 59), 270 pp, paper, 2008

ISBN-13 978-1-888569-98-8

stock 540.59P

list price \$69

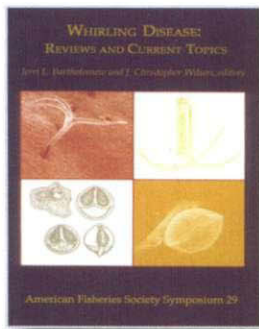
member price \$48



Aquaculture in the 21st Century
Anita Kelly and Jeff Silverstein, eds.

Aquaculture in the 21st Century is the second volume in the Manual of Fish Culture series. This volume provides the detail and utility for the culture of aquatic organisms that made the first volume indispensable to culturists. Additionally, historical and background material are provided for each of the 26 species covered, which makes this book useful to those more generally interested in aquaculture and the development of aquaculture. The extent of the material provided makes it not only a valuable reference tool, but also an excellent resource for aquaculture courses.

(SY 46), 643 pp, paper, 2006
 ISBN-10 1-888569-71-9
 ISBN-13 978-1-888569-71-1
 stock 540.46P
 list price \$69
 member price \$48

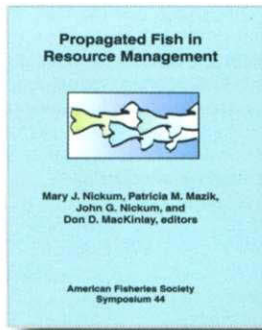


Whirling Disease: Reviews and Current Topics

Jeri L. Bartholomew and J. Christopher Wilson, eds.

This book is a compilation of the latest whirling disease research findings, along with seven invited review papers in seven subtopics. It represents a peer-reviewed version of the proceedings of the 7th Annual Whirling Disease Symposium held in February 2001 in Salt Lake City. Given the value of its extensive and thoroughly researched review papers, this volume a valuable resource for researchers in the field as well as a reference volume for managers who have to make decisions on controlling whirling disease.

(SY29), 247 pp, paper, 2002
 ISBN-10 1-888569-37-9
 ISBN-13 978-1-888569-37-7
 stock 540.29P
 list price \$69
 member price \$48



Propagated Fish in Resource Management

Mary J. Nickum, Patricia M. Mazik, John G. Nickum, and Don D. MacKinlay, eds.

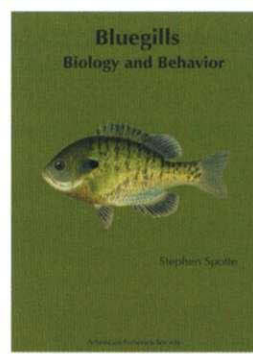
This book contains the peer-reviewed technical papers presented at a June 2003 symposium examining the effective use of fish culture as a tool for fisheries resource management.

The symposium identified information gaps in technical knowledge, debated the appropriateness of assumptions and current theories being used to make resource management decisions, and attempted to reconcile philosophical differences that have become an obstacle to science-based resource management. (SY 44), 644 pp, hardcover, 2005
 ISBN-10 1-888569-69-7
 ISBN-13 978-1-888569-69-8
 stock 540.44C
 list price \$75
 member price \$53

Manual of Fish Culture
AFS Fish Culture Section

A Manual of Fish Culture, originally published by the U.S. Commission on Fisheries in 1897, contains descriptions of culture techniques for more than 40 species or groups of finfishes, plus lobsters, oysters, clams, and frogs. When published, it contained all the information needed by fish culturists. The techniques and practices described in the Manual became the standard for aquaculturists and the forerunner of the technical publications of today. This reprint of the 1897 book was produced by the Fish Culture Section of the American Fisheries Society.

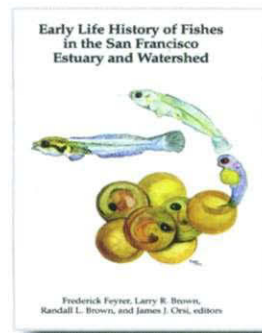
340 pp + 80 plates, hardcover, 1999
 ISBN-10 1-888569-16-6
 ISBN-13 978-1-888569-16-2
 stock 530.28C
 list price \$50
 member price \$35



Bluegills: Biology and Behavior

The bluegill is arguably the most popular freshwater sportfish in North America – it has been introduced into every state but Alaska. Bluegills also have been exported worldwide for sport, aquaculture, or as forage for larger fishes. Spotte's book is a synopsis of what we know about bluegills. He discusses not just *what* bluegills do, but also *how* they go about doing it.

214 pp, paper, 2007
 ISBN-13 978-1-888569-93-3
 stock 550.54P
 list price \$35
 member price \$25

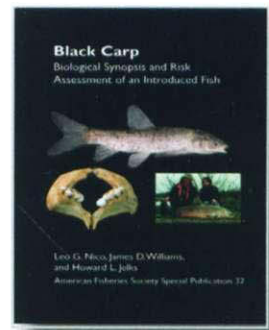


Early Life History of Fishes in the San Francisco Estuary and Watershed

Frederick Feyrer, Larry R. Brown, Randall L. Brown, and James J. Orsi, eds.

This book is the primary source of information on the early life history of fishes in the San Francisco Estuary and its watershed. It contains more papers on fish early life history in the system than all previous publications combined. In addition to providing a resource for people generally interested in the system, original papers on feeding ecology, growth, environmental requirements of species, community ecology, emerging modeling techniques, development, and toxicology will benefit scientists specializing in a variety of disciplines.

(SY39), 295 pp, paper, 2004
 ISBN-10 1-888569-59-X
 ISBN-13 978-1-888569-59-9
 stock 540.39P
 list price \$60
 member price \$42

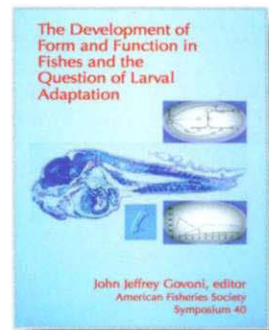


Black Carp: Biological Synopsis and Risk Assessment of an Introduced Fish

Leo G. Nico, James D. Williams, and Howard L. Jelks

This book is a detailed risk assessment and biological synopsis of the black carp, a large mollusk-eating cyprinid fish native to eastern Asia. A great deal of controversy surrounds the presence of this foreign fish in the United States. Most of those associated with the aquaculture industry view black carp as an important tool in controlling disease-carrying snails that infest aquaculture ponds. Those interested in mollusk protection and groups involved with aquatic ecosystem conservation are concerned that continued use of black carp by U.S. aquaculturists will lead to the species' establishment in open waters.

(SP32), 316 pp, hardcover, 2005
 ISBN-10 1-888569-68-9
 ISBN-13 978-1-888569-68-1
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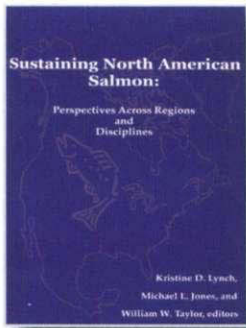


The Development of Form and Function in Fishes and the Question of Larval Adaptation

John Jeffrey Govoni, editor

Understanding how larval fish function, how they acquire energy to grow, and how they expend energy to survive is basic to any endeavor in either mariculture or aquaculture. The book reviews the development of form and function in the following major anatomical systems: gross external anatomy (swimming), the integument (osmoregulation and taste), the alimentary canal, other visceral organs, the swim bladder, gills, and sensory systems, as well as blood and circulation.

(SY40), 198 pp, paper, 2004
 ISBN-10 1-888569-58-1
 ISBN-13 978-1-888569-58-2
 stock 540.40P
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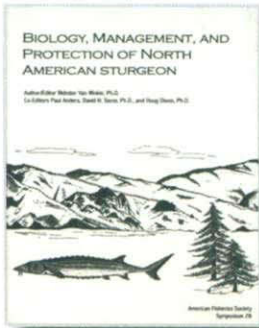


Sustaining North American Salmon: Perspectives Across Regions and Disciplines

Kristine D. Lynch, Michael L. Jones, and William W. Taylor, eds.

U.S. and Canadian fisheries professionals from multiple disciplines examine the history, current knowledge, and research needs of fisheries stakeholders, managers, and policy makers regarding salmon ecology, policy, and management in North America. The book offers a greater understanding of the complexity and repercussions of salmon management, currently a controversial issue between Canada and the United States. Canadian and U.S. fisheries professionals across multiple disciplines identify future information needs from biological, social, and economic perspectives, enabling managers and policy makers to develop an action agenda to acquire and utilize this information. This excellent reference for the management of salmon presents a synthesis of the history, ecology, sociology, economics, politics/institutions, and future of one of the most economically and culturally significant fishes in America.

395 pp, paper, 2002
 ISBN-10 1-888569-25-5
 ISBN-13 978-1-888569-25-4
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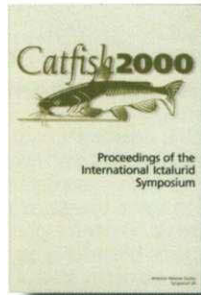


Biology, Management, and Protection of North American Sturgeon

Webster Van Winkle, Paul J. Anders, David H. Secor, and Doug A. Dixon, eds.

This multi-authored symposium volume addresses the vulnerability and continuing decline of numerous sturgeon species and stocks and the intense efforts to manage and protect them. Written by scientists, resource managers, and electric utility industry personnel with a shared interest in sturgeon biology and ecology, management, and protection, this book includes life history characteristics relevant to population dynamics, viability, and

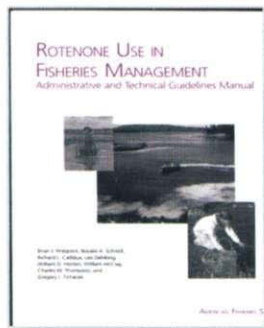
persistence; upstream and downstream migratory behavior; habitat requirements and local movement; passage technologies; and conservation management and stock enhancement. Most major sturgeon species in America are covered, including shortnose, Atlantic, Gulf, lake, pallid, shovelnose, white, and green sturgeon.
 (SY28), 258 pp, paper, 2002
 ISBN-10 1-888569-36-0
 ISBN-13 978-1-888569-36-0
 stock 540.28P
 list price \$60
 member price \$42



Catfish 2000: Proceedings of the International Ictalurid Symposium
 Elise R. Irwin et al., eds.

This book integrates original new research and recent literature reviews into the first collective work describing the biology and management of catfish. This volume seeks to serve as a milestone and catalyst for more effective management of ictalurids and preservation of diversity. It is a major reference text for catfish biologists and managers. Topics include reviews of important species; biology and ecology (including life history, habitat use, movement, and genetics); and recent innovations in management (including collection methods, assessment techniques, stocks, human dimensions, regulation of harvest, effects of maintenance stocking, and nonnative introductions).

(SY24), 516 pp, hardcover, 2000
 ISBN-10 1-888569-19-0
 ISBN-13 978-1-888569-19-3
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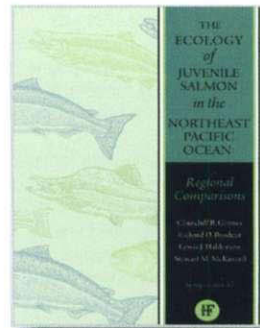


Rotenone Use in Fisheries Management: Administrative and Technical Guidelines Manual
 Brian J. Finlayson et al.

This manual promotes the continued safe and effective use of rotenone as a pesticide and as a sampling tool of fish populations and makes specific recommendations for the administrative

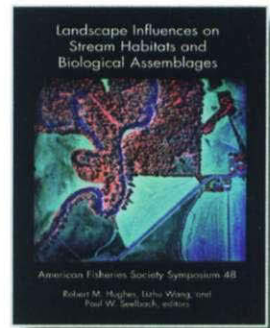
and technical procedures for rotenone applications that will ensure its continued availability as a valuable fish management tool. In a well-organized format, it outlines step-by-step procedures for planning and executing a treatment project and for addressing public health and safety issues and environmental concerns.
 200 pp, paper, 2000
 ISBN-10 1-888569-22-0
 ISBN-13 978-1-888569-22-3
 stock # 550.32P
 list price \$50
 member price \$35

ECOLOGY



The Ecology of Juvenile Salmon in the Northeast Pacific Ocean: Regional Comparisons
 Churchill B. Grimes, Rick Brodeur, Skip McKinnell, and Lew Haldorson, eds.

Understanding the interaction between Pacific salmon and their environment is critical for salmon management. This book presents recent advances in our understanding of the ecology of salmon in the North Pacific and Bering Sea and the influence of ocean climate on the life history and population dynamics of Pacific salmon stocks. Focuses on regional comparisons of salmon ecology south and north of the British Columbia transition zone where ocean conditions effect salmon production in opposite phase.
 (SY 57), 247 pp, paper, 2007
 ISBN-13 978-1-888569-95-7
 stock 540.57P
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 member price \$48



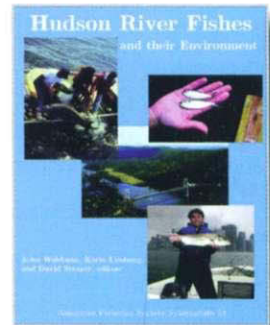
Landscape Influences on Stream Habitats and Biological Assemblages

Robert M. Hughes, Lizhu Wang, and Paul W. Seelbach, eds.

This book synthesizes current knowledge of the influences of landscape on stream ecosystems, and evaluates the potential for watershed management and instream restoration. It identifies knowledge gaps to direct future research in linking landscape features and instream physicochemical and biological conditions.

Includes chapters on (1) GIS and statistical tools that best link landscape with stream conditions, (2) effects of natural landscape features on stream conditions, (3) effects of human induced land cover on stream conditions, and (4) influences of spatial and temporal scales on the effects of the natural landscape and human-induced land cover on stream conditions.

The book will appeal to a wide spectrum of resource professionals ranging from academic researchers to agency managers.
 (SY 48), 697 pp, paper, 2006
 ISBN-10 1-888569-76-X
 ISBN-13 978-1-888569-76-6
 stock 540.48P
 list price \$69
 member price \$48

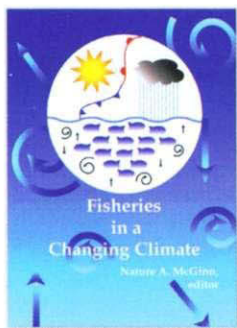


Hudson River Fishes and Their Environment
 John Waldman, Karin Limburg, and David Strayer, eds.

Contains new findings about the ecological and environmental workings of the Hudson River and the effects on fishes. Chapter authors present important new findings, including the effects of zebra mussels that colonized the river in 1991 and concomitant changes in macrophyte beds, the impact of changing land use on the watershed, increasing use

of the Hudson by anglers, and the status of fish populations including the decline of Atlantic sturgeon.

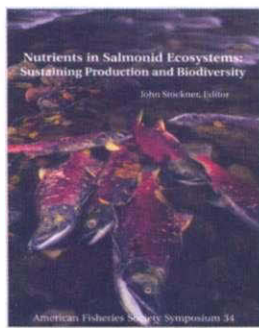
(SY 51), 365 pp, paper, 2006
 ISBN-10 1-888569-82-4
 ISBN-13 978-1-888569-82-7
 stock 540.51P
 list price \$69
 member price \$48



Fisheries in a Changing Climate
 Nature A. McGinn, ed.

This book covers a wide geographical area from oceanic fisheries in the northwest Atlantic and northeast Pacific, to inland fisheries in the Great Lakes and western U.S. rivers and streams. In addition to fisheries science research, some chapters detail the impacts of climate change on aquatic ecosystems and fisheries policy and management. This comprehensive volume will be a valuable resource for anyone with an interest in these topics and will serve as a guide to those continuing to research the future of fisheries in a changing climate.

(SY32), 295 pp, paper, 2002
 ISBN-10 1-888569-40-9
 ISBN-13 978-1-888569-40-7
 stock 540.32P
 list price \$60
 member price \$42

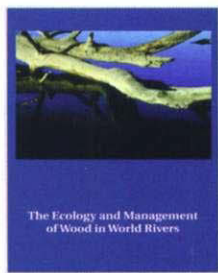


Nutrients in Salmonid Ecosystems: Sustaining Production and Biodiversity
 John Stockner, ed.

The proceedings of the 2001 conference Restoring Nutrients to Salmonid Ecosystems and the first book of its kind, this volume presents recent information on the role and importance of marine-derived nutrients in salmonid ecosystems. The authors examine how this research can be used effectively to assist in rebuilding salmonid stocks in the Pacific Northwest.

(SY34), 285 pp, paper, 2003
 ISBN-10 1-888569-44-1
 ISBN-13 978-1-888569-44-5

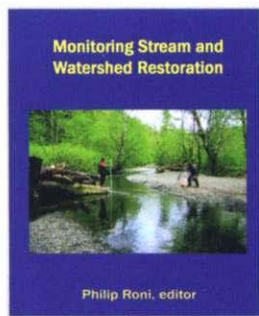
stock 540.34P
 list price \$60
 member price \$42



The Ecology and Management of Wood in World Rivers
 Stan V. Gregory, Kathryn L. Boyer, and Angela M. Gurnell, eds.

Proceedings of the International Conference on Wood in World Rivers in Corvallis, Oregon. The volume synthesizes world knowledge about large wood in streams and rivers in relation to physical and ecological processes and stream restoration.

(SY37), 431 pp, paper, 2003
 ISBN-10 1-888569-56-5
 ISBN-13 978-1-888569-56-8
 stock 540.37P
 list price \$75
 member price \$53



Monitoring Stream and Watershed Restoration
 Philip Roni, ed.

Millions of dollars are invested annually in aquatic restoration, yet little guidance exists on how to monitor and evaluate these activities. This long-awaited book provides a practical resource for designing and implementing monitoring and evaluation programs for restoration activities at various scales—from individual, site-specific actions to multiple projects throughout a watershed.

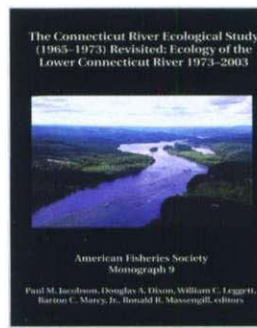
Chapters are organized around the major types of restoration techniques, including road improvements, riparian silviculture, fencing and grazing management, floodplains, estuarine, instream, nutrient enrichment, and acquisitions and conservation easements. Also includes chapters on economic evaluation and monitoring design.

The book will particularly appeal to scientists evaluating restoration techniques, to groups implementing restoration, and to agencies and entities responsible for funding restoration efforts.

Customers outside North and Central America order from:

CABI Publishing, Nosworthy Way, Wallingford, Oxon OX10 8DE, United Kingdom

350 pp, paper, 2005
 ISBN-10 1-888569-63-8
 ISBN-13 978-1-888569-63-6
 stock 550.47P
 list price \$65
 member price \$45

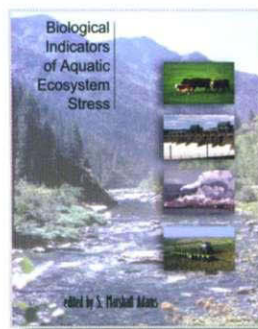


The Connecticut River Ecological Study (1965-1973) Revisited: Ecology of the Lower Connecticut River 1973-2003

Paul M. Jacobson, Douglas A. Dixon, William C. Leggett, Barton C. Marcy, Jr., and Ronald R. Massengill, eds.

This book contains the original Connecticut River Ecological Study: Impacts of a Nuclear Power Station (AFS Monograph 1), updated with a compilation of retrospective papers targeting key contemporary ecological and regulatory issues in relation to the issues investigated and predictions made in the early 1970s. The Connecticut River study was one of the first large-scale, comprehensive studies to assess the ecological impact of a steam electric power plant that utilizes once-through cooling and is located on a major tidal river.

(M9), 545 pp, paper, 2004
 ISBN-10 1-888569-66-2
 ISBN-13 978-1-888569-66-7
 stock 520.09P
 list price \$69
 member price \$48



Biological Indicators of Aquatic Ecosystem Stress
 S. Marshall Adams, ed.

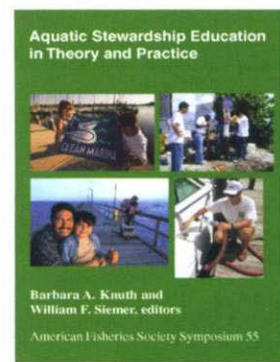
A practical guide to the use of bioindicators for assessment of the effects of environmental stressors on aquatic ecosystems and organisms, especially fish. Written by scientists who are the best in their fields, this book provides helpful information for designing and applying bioindicators in the field to reliably assess the health of aquatic organisms and the ecosystems.

This volume may be used as a manual for scientists, students, and others, in a variety of disciplines and applications.

Customers outside North and Central America order from: CABI Publishing, Nosworthy Way, Wallingford, Oxon OX10 8DE, United Kingdom
 644 pp, 2002
 ISBN-10 hardcover 1-888569-28-X
 ISBN-13 hardcover 978-1-888569-28-5
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 list price hardcover \$89
 member price hardcover \$62

ISBN-10 paper 1-888569-43-3
 ISBN-13 paper 978-1-888569-43-8
 stock paper 550.37P
 list price paper \$69
 member price paper \$48

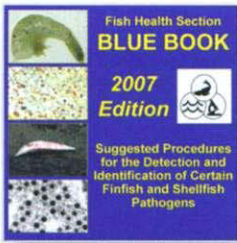
EDUCATIONAL & PROFESSIONAL TOOLS



Aquatic Stewardship Education in Theory and Practice
 Barbara A. Knuth and William F. Siemer, eds.

This topical book presents the most current thinking about how to define, foster, and evaluate desirable aquatic stewardship behaviors as well as how to develop the educational programs and other motivating forces underlying such behaviors. This effort represents a partnership among academics, aquatic resource educators, fishery management professionals, and the fishing and boating industries to develop a shared understanding of desired characteristics of aquatic resource stewardship.

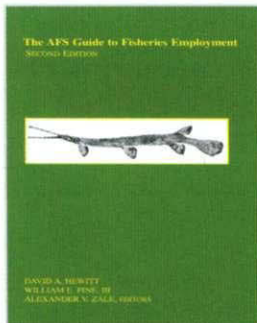
(SY 55), 187 pp, paper, 2007
 ISBN-13 978-1-888569-90-2
 stock 540.55P
 list price \$60
 member price \$42



Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens, 2007 Edition

Originally published in loose-leaf format as the Blue Book, this updated, searchable CD contains both the familiar chapters of the "Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens" and the newly revised "Standard Procedures for Aquatic Animal Health Inspections" coauthored by the U.S. Fish and Wildlife Service and the AFS Fish Health Section. This new format allows the user to easily access information and contains numerous color photographs and video clips.

CD-ROM, 2007, updated annually
 ISBN-13 978-1-888569-94-0
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 stock 703.14
 list price \$100
 member price \$70
 3-YEAR SUBSCRIPTION
 stock 703.145
 list price \$150
 member price \$105



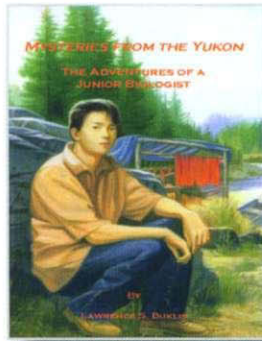
AFS Guide to Fisheries Employment, 2nd Edition

David A. Hewitt, William E. Pine III, and Alexander V. Zale, eds.

This updated handbook provides education, employment, career advancement, and professional development guidance to fisheries students and professionals. Includes practical advice on building undergraduate skills, designing an effective resume, and pursuing graduate studies. Experienced fisheries professionals discuss fisheries careers with state and federal agencies, academia, cooperative research units, nongovernmental organizations, and private consultants. Also examines foreign employment, equal opportunity issues, things to know about assuming administrative positions, and how AFS can help individuals become fisheries professionals.

229 pp, paper, 2006
 ISBN-10 1-888569-86-7

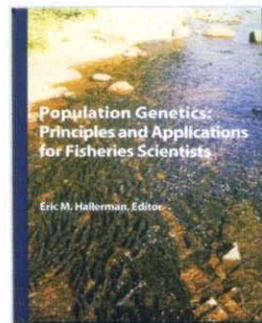
ISBN-13 978-1-888569-86-5
 stock 550.53
 list price \$12
 member price \$8



Mysteries from the Yukon: Three Fisheries Adventures for Students
 Lawrence S. Buklis

Searching for lost gold from the Klondike, chasing thieves in a blinding snowstorm, plunging through raging waters on a hydropower project gone wrong—three fast-paced adventures await readers in grades 5 through 9. Through the experiences of a fisheries biologist and his family on the legendary Yukon River, these adventures help feed the dream: Could this be me?

217 pp, paper, 2003
 ISBN-10 1-888569-52-2
 ISBN-13 978-1-888569-52-0
 stock 550.46P
 list price \$21
 member price \$15



Population Genetics: Principles and Applications for Fisheries Scientists

Eric M. Hallerman, ed.

This book serves as a welcome and badly needed teaching resource in the field of fisheries genetics. This multi-authored volume finally makes the subject of population genetics relevant and fully accessible to students and practitioners of fisheries science. A textbook for both university and lifelong students, it discusses the principles and applications of population genetics, specifically within the fisheries field. This is the first textbook of its kind.

458 pp, hardcover, 2003
 ISBN-10 1-888569-27-1
 ISBN-13 978-1-888569-27-8
 stock 550.34C
 list price \$69
 member price \$48

Fish Slide Catalog (AFS), Fifth Edition

The AFS slide collection contains 980 slides (35 mm) of North American fishes. These slides serve as a valuable educational resource at all levels of education, from grade school to university, and in a wide variety of applications, such as training law enforcement personnel and talks before scientific societies and angling clubs. Slides sold by AFS are distributed with the understanding that they will be used only in optical projection for non-profit educational purposes. Any other use, nonprofit or commercial, requires the consent of the contributor(s), who retain all copyrights to their slides.

36 pp, paper, 1997
 stock 055
 slide catalog, each \$2.85
 slides, each \$4.50
 Minimum order \$25

Introduction to Infectious Diseases of Salmonid Fishes

AFS Continuing Education Program

This 64-minute CD/video course on infectious diseases describes how to collect samples and perform the initial steps in diagnosing disease agents. Segments introduce the most common pathogens of salmon and trout.

Includes 28 pp corresponding pamphlet, 2002
 CD stock 703.11
 VHS video stock 702.08
 list price \$49
 member price \$34
 Please specify either CD or VHS video (same price).

GUIDES AND FAUNA

NEW

Grenadiers of the World Oceans: Biology, Stock Assessment, and Fisheries

Alexei M. Orlov and Tomio Iwamoto, eds.

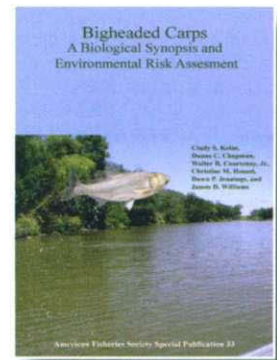
(SY 63), 484 pp, paper, 2008
 ISBN-13 978-1-934874-00-4
 stock 540.63P
 list price \$69
 member price \$48

NEW

Red Snapper Ecology and Fisheries in the U.S. Gulf of Mexico

William F. Patterson, III, James H. Cowan, Jr., Gary R. Fitzhugh, and David L. Nieland, eds.

(SY 60), 396 pp, paper, 2008
 ISBN-13 978-1-888569-97-1
 stock 540.60P
 list price \$69
 member price \$48



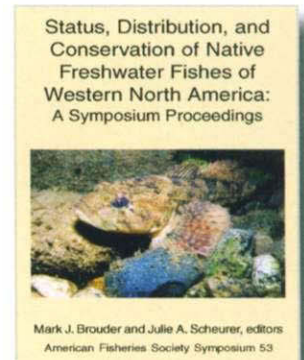
Bigheaded Carps: A Biological Synopsis and Environmental Risk Assessment

Cynthia Kolar, Walter Courtenay, Jr., Duane Chapman, Christine Housel, James Williams, and Dawn Jennings

The book is a detailed risk assessment and biological synopsis of the bigheaded carps of the genus *Hypophthalmichthys*, which includes the bighead, silver, and largescale silver carps. It summarizes available scientific literature describing their biology, ecology, uses, ecological effects, and risks to the environment.

Major subjects addressed are (1) taxonomy and descriptions of the genus and species, (2) native distributions and habitat preferences, (3) biology and natural history, with emphasis on diet and reproduction, (4) diseases and parasites associated with each species, (5) history of the introduction of the fishes within and outside the United States, (6) a review of the human uses of species in the genus, (7) a discussion of the potential ranges of the species in the United States, (8) a review of current federal and state regulations for each species, and (9) an assessment of the risk posed by these species in the United States.

(SP 33), 185 pp, hardcover, 2007
 ISBN-10 1-888569-79-4
 ISBN-13 978-1-888569-79-7
 stock 510.33C
 list price \$60
 member price \$42

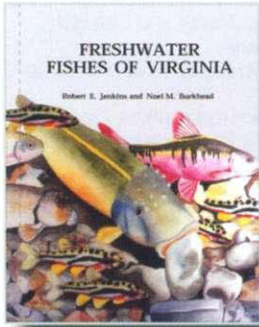


Status, Distribution, and Conservation of Native Freshwater Fishes of Western North America
 Mark J. Brouder and Julie A. Scheurer, eds.

Throughout the western United States, Canada, and northern Mexico during the past century, the status of many western native freshwater fish species has become

questionable. Native fish have been adversely impacted by land and watershed development, habitat loss, direct human harvest, and increased competition from introduced non-native fish species. As population growth within the western region continues, understanding where remaining populations of native fish fauna occur and the threat presented to them is critical for conservation and restoration.

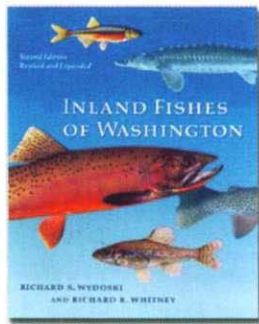
(SY 53), 207 pp, paper, 2007
 ISBN-13 978-1-888569-89-6
 stock 540.53P
 list price \$69
 member price \$48



Freshwater Fishes of Virginia
 Robert E. Jenkins and Noel M. Burkhead

Exhaustive treatment of 210 species of Virginia's freshwater ichthyofauna. Introductory chapters on Virginia's natural history, drainages and habitat, biogeography, and endangered species are followed by species accounts within 24 families. An extensive reference list and glossary complete the book. Abundant illustrations, detailed keys, distribution maps, and 40 pages of color plates make this a monumental reference.

1080 pp, hardcover, 1994
 ISBN-10 0-913235-87-3
 ISBN-13 978-0-913235-87-4
 stock 550.20C
 list price \$110
 member price \$77

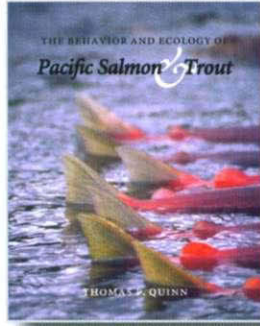


Inland Fishes of Washington, Second Edition
 Richard S. Wydoski and Richard R. Whitney

This new, updated, and greatly expanded edition describes all the known native and introduced fishes found in freshwater habitats of Washington State, including most of the fishes of Oregon, Idaho, and British Columbia. The authors have created a valuable reference for the general public, biologists, teachers,

students, and environmentalists.

360 pp, hardcover,
 113 color plates, 2003
 ISBN-10 0-295-98338-8
 ISBN-13 978-0-295-98338-7
 stock 637.06C
 list price \$55
 member price \$39

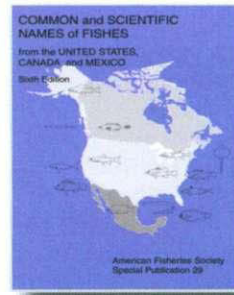


The Behavior and Ecology of Pacific Salmon and Trout
 Thomas P. Quinn

Few subjects have generated as much emotional dialogue around conflicting scientific and policy agendas as the protection and management of Pacific salmon resources. In this major new work, Thomas Quinn distills from the vast scientific literature the essential information on the behavior and ecology of Pacific salmon, including steelhead and cutthroat trout. Unlike other books that examine only selected life stages, habitats, or species, this book—richly illustrated with beautiful photographs and original drawings—thoroughly covers the complete life cycle, emphasizing common themes and differences among the various species of salmon.

Representing the range of species and geographic regions, the book includes examples from classic studies by pioneers of salmon biology and from the most current research to illustrate the important features of salmon life history and behavior and the complex physical, biological, and human factors that affect them.

328 pp, 64 in color, paper, 2005
 ISBN-10 0-295-98457-0
 ISBN-13 978-0-295-98457-5
 stock 637.07P
 list price \$35
 member price \$25



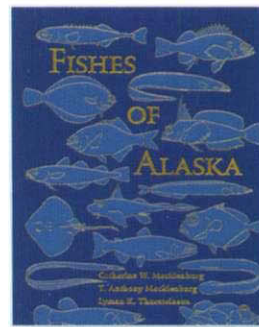
Common and Scientific Names of Fishes from the United States, Canada, and Mexico, Sixth Edition
 Joseph S. Nelson, Edwin J. Crossman, Héctor Espinosa-Pérez, Lloyd T. Findley, Carter R. Gilbert, Robert N. Lea, and James D. Williams

This authoritative reference provides an accurate, up-to-date checklist of common and scientific names for all described and taxonomically valid fish species living in fresh and marine waters of North America. This edition contains 1,271 additional species and reflects numerous taxonomic changes that have occurred since 1991. Includes 3,700 species, 262 families, 52 established exotics, 13 named hybrids, the rationale and methodology for common name allocation, history of changes from the previous edition, and extensive references.

Also includes Spanish and French names. INCLUDES A COMPANION CD-ROM.

Compiled in cooperation with the American Society of Ichthyologists and Herpetologists.

(SP29), 386 pp, hardcover, 2004
 ISBN-10 1-888569-61-1
 ISBN-13 978-1-888569-61-2
 stock 510.29C
 list price \$60
 member price \$42



Fishes of Alaska
 Catherine W. Mecklenburg, T. Anthony Mecklenburg, and Lyman K. Thorsteinson

Fishes of Alaska is the only comprehensive guide to the marine and freshwater fishes of Alaska. Coverage extends out to the U.S. 200-mile limit, down to the abyssal plain, and to the adjacent waters of Russia and Canada with accounts of 601 species in 108 families and 36 orders. Identification keys, species accounts, and introductions to the higher taxa are presented in the framework of a modern classification. Color plates, gazetteer, glossary, extensive bibliography, and detailed

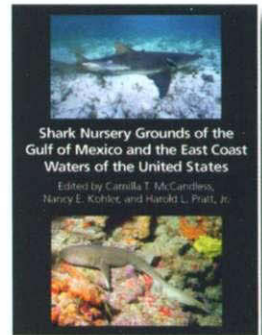
index are included. This catalog of species with a consistent body of descriptive and source materials under one cover composes a useful reference for marine biologists, ichthyologists, natural resource managers, students, naturalists, and others seeking authoritative information on the species.

1,038 pp + 40 color plates, hardcover, 2002
 ISBN-10 1-888569-07-7
 ISBN-13 978-1-888569-07-0
 stock 530.27C
 list price \$129
 member price \$90

HABITAT

NEW

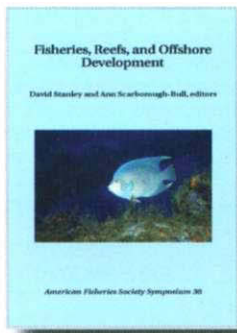
Advances in Fisheries Bioengineering
 Stephen V. Amaral, Dilip Mathur, and Edward P. Taft, III, eds.
 (SY 61), 239 pp, paper, 2008
 ISBN-13 978-1-934874-02-8
 stock 540.61P
 list price \$69
 member price \$48



Shark Nursery Grounds of the Gulf of Mexico and the East Coast Waters of the United States
 Camilla T. McCandless, Nancy E. Kohler, and Harold L. Pratt, Jr., eds.

Until recently, detailed reports of the shark nursery grounds off the U.S. East Coast and the Gulf of Mexico have been nonexistent. In this book, researchers from universities and state and federal agencies in 12 U.S. states bordering the northwestern Atlantic Ocean and the Gulf of Mexico from Massachusetts to Texas contribute extensive nursery study data. Data were gathered using different methods, including longline, gill-net, and trawl surveys. Raw data on juvenile shark catch and environmental parameters associated with the catches are provided to enable a synthesis of species, summary tables, and maps.

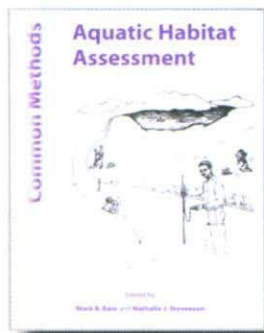
(SY 50), 390 pp, paper, 2007
 ISBN-10 1-888569-81-6
 ISBN-13 978-1-888569-81-0
 stock 540.50P
 list price \$69
 member price \$48



Fisheries, Reefs, and Offshore Development
David Stanley and Ann Scarborough-Bull, eds.

Proceedings of the Gulf of Mexico Fish and Fisheries meeting, focusing on the impact and effects of oil and gas development on fish and fisheries in the Gulf of Mexico. The book covers (1) an evaluation of natural and artificial reef productivity, (2) fisheries management in the Gulf of Mexico, (3) a compilation of offshore petroleum platform assemblage research, (4) the impact of outer continental shelf (OCS) development on the marine community, (5) OCS and deepwater marine ecology, and (6) artificial reefs and fisheries management.

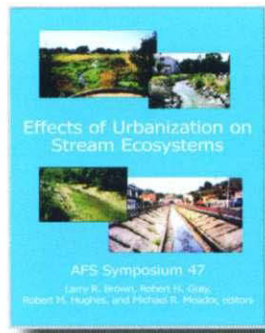
(SY36), 238 pp, paper, 2003
ISBN-10 1-888569-54-9
ISBN-13 978-1-888569-54-4
stock 540.36P
list price \$60
member price \$42



Aquatic Habitat Assessment: Common Methods
Mark B. Bain and Nathalie J. Stevenson, eds.

This manual represents the synthesis of a comprehensive survey of the most widely used methods for inland aquatic habitat assessment in North America. The purpose of this manual is to reduce the variability in approaches to habitat assessment, while still providing flexibility for selecting practices that vary in effort, cost, precision, and detail.

216 pp, paper, 1999
ISBN-10 1-888569-18-2
ISBN-13 978-1-888569-18-6
stock 550.28P
list price \$33
member price \$23



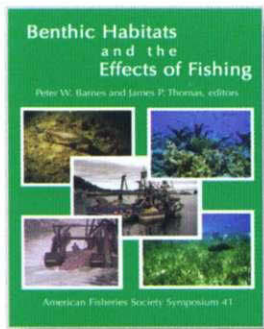
Effects of Urbanization on Stream Ecosystems

Larry R. Brown, Robert M. Hughes, Robert Gray, and Michael R. Meador, eds.

As human populations continue to grow, the effects of urbanization on streams and other habitats will become increasingly important to aquatic resource managers. Urbanization of watersheds is almost invariably accompanied by loss and alteration of aquatic habitats, two of the most frequently mentioned causes for losses of aquatic biota.

This book includes a variety of case studies addressing the effects of urbanization on stream ecosystems at locations ranging from Brazil to Southern California to New York. Of special interest is a group of five papers resulting from an interdisciplinary comparative study of urbanization in Boston, MA, Birmingham, AL, and Salt Lake City, UT. These papers address regional variations in study design and responses of habitat, benthic algae, benthic macroinvertebrates, and fish to urban development.

(SY 47), 423 pp, paper, 2005
ISBN-10 1-888569-73-5
ISBN-13 1-888569-73-5
stock 540.47P
list price \$69
member price \$48



Benthic Habitats and the Effects of Fishing

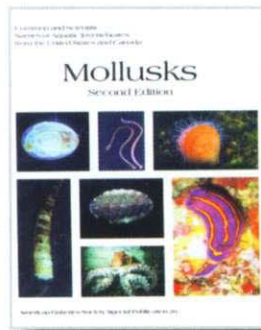
Peter W. Barnes and James P. Thomas, eds.

Fishery resource managers face the challenge of ensuring sustainable fisheries and maintaining healthy, diverse ecosystems. This challenge can be met by advancing the scientific knowledge available to resource managers to evaluate and appropriately manage fishing activities that affect benthic habitats. Government agencies have been working to develop benthic habitat research initiatives focused on the effects of fishing gear and the linkage between biological

resources and the geology of benthic habitats. This book provides the broad understanding of the effects of fishing activities on benthic habitats necessary to address the pressing issues of habitat alteration that challenge managers, practitioners, and ocean scientists.

(SY41), 890 pp, hardcover, 2005
ISBN-10 1-888569-60-3
ISBN-13 978-1-888569-60-5
stock 540.41C
list price \$75
member price \$53

INVERTEBRATES



Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Mollusks, Second Edition

Donna D. Turgeon et al.

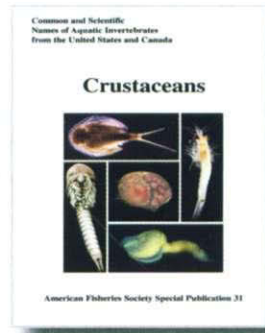
This edition updates the nomenclature to reflect recent phylogenetic analysis, and contains more than 300 new species. Several detailed appendices have been added: changes and additions to the first edition nomenclature, revised lists of endangered and possibly extinct species, a list of nonindigenous species, a general overview of molluscan biology and ecology information, information about collecting and collections, recommendations for guidebooks and keys, and a directory of major North American museum collections. An expanded color portfolio section illustrates the diversity of fauna within this group of invertebrates. Compiled in cooperation with the Council of Systematic Malacologists and the American Malacological Union, this edition covers the 6,272 marine, freshwater, and terrestrial mollusks of the USA and Canada.

Mollusks CD

A companion CD-ROM contains the entire text and figures from Names of Mollusks, allowing professionals and researchers electronic access to all the data contained in the printed book.

Mollusks book and CD

(SP26), 535 pp, paper, 1998
ISBN10 1-888569-01-8
ISBN13 978-1-888569-01-8
stock 510.26P
list price \$59
member price \$41

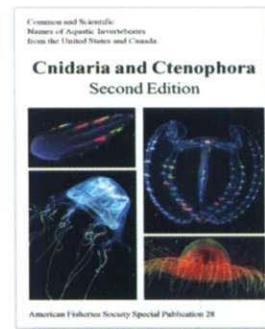


Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Crustaceans

Patsy A. McLaughlin, David K. Camp et al.

This edition represents the second edition of the list of decapod crustaceans and the first edition of the list of all other crustacean groups, including terrestrial, freshwater, and marine forms. The list has been greatly expanded to include more than 9,000 species from the United States (now including Hawaiian species) and Canada. Several detailed appendices have been added, including changes and additions to the entries for decapod crustaceans from the first edition and lists of endangered or threatened species, presumably extinct species, and nonindigenous species. The introduction is also expanded to include a detailed description of the diversity within the subphylum Crustacea. This reference was compiled in cooperation with The Crustacean Society.

Includes a companion CD-ROM.
(SP31) 545 pp, paper, 2005
ISBN-10 1-888569-64-6
ISBN-13 978-1-888569-64-3
stock 510.31P
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Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Cnidaria and Ctenophora, Second Edition

Stephen D. Cairns et al.

This volume (updated since the first edition and now with a CD-ROM) provides a checklist of species and recommends selected common names for North American Cnidaria and Ctenophora, thereby achieving uniformity and avoiding confusion over common names. In addition to stabilizing

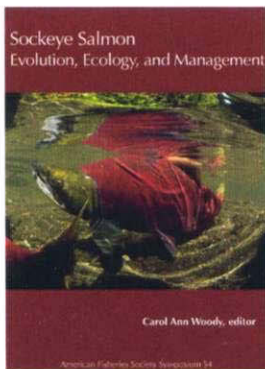
common name nomenclature, this list will heighten public awareness of the diversity and wide distribution of cnidarians in North America, help identify taxonomic groups in need of systematic revision, and serve as a preliminary guide to the literature required for the identification of species. This text lists more than 1,300 taxa of jellyfishes, hydroids, corals, anemones, and comb jellies and sets the standard for vernacular names of the more widely known species. This book includes an index, extensive references and bibliography, and annotated changes from the first edition.

- BOOK AND CD
(SP28), 115 pp + 32 color photos,
paper, 2003
ISBN-10 1-888569-39-5
ISBN-13 978-1-888569-39-1
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list price \$39
member price \$27
CD ONLY
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MANAGEMENT

NEW

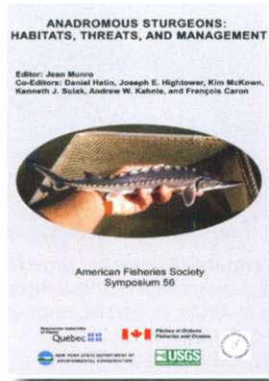
Reconciling Fisheries with Conservation: Proceedings of the Fourth World Fisheries Congress
Jennifer Nielsen, Julian Dodson, Kevin Friedland, Troy Hamon, John Musick, and Eric Verspoor, eds.
(SY 49), 1,946 pp, paper, 2008
ISBN-10 1-888569-80-8
ISBN-13 978-1-888569-80-3
stock 540.49P
list price \$75
member price \$53



Sockeye Salmon Evolution, Ecology, and Management
Carol Ann Woody, ed.

The importance of sockeye salmon *Oncorhynchus nerka* to commercial and subsistence fisheries around the Pacific Rim has led to over a century of research on their evolution and ecology. This volume compiles 12 manuscripts or extended abstracts from the 2005 symposium *Sockeye Salmon Ecology, Evolution, Life History, and Management* in Anchorage, Alaska. Exciting work in all four major themes is included. 11 full-color pages.
(SY 54), 129 pp, paper, 2007

- ISBN-13 978-1-888569-88-9
stock 540.54P
list price \$60
member price \$42



Anadromous Sturgeons: Habitats, Threats, and Management
Jean Munro, Daniel Hatin, Joseph E. Hightower, Kim McKown, Kenneth J. Sulak, Andrew W. Kahnle, and François Caron, eds.

Because of their threatened status, sturgeons have been the focus of broad scientific interest. This book provides new information on freshwater, estuarine, and marine habitats of anadromous sturgeons; examines threats to habitats and populations; and reviews management and population trends in light of progress on recovery of U.S. Atlantic sturgeon populations since fishing was banned.
(SY 56), 415 pp, paper, 2007
ISBN-13 978-1-888569-91-9
stock 540.56P
list price \$69
member price \$48

NEW

Eels at the Edge
John M. Casselman and David Cairns, eds.
(SY 58), 400 pp est., hardcover, 2007
ISBN-13 978-1-888569-96-4
stock 540.58C
list price \$69
member price \$48

NEW

Burbot: Ecology, Management, and Culture
Vaughn L. Paragamian and David H. Bennett, eds.
(SY 59), 270 pp, paper, 2008
ISBN-13 978-1-888569-98-8
stock 540.59P
list price \$69
member price \$48

NEW

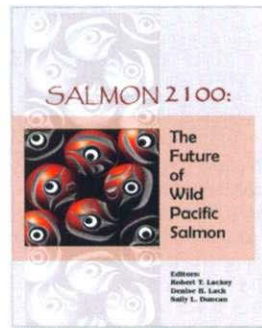
Advances in Fisheries Bioengineering
Stephen V. Amaral, Dilip Mathur, and Edward P. Taft, III, eds.
(SY 61), 239 pp, paper, 2008
ISBN-13 978-1-934874-02-8
stock 540.61P
list price \$69
member price \$48

NEW

Mitigating Impacts of Natural Hazards on Fishery Ecosystems
Katherine D. McLaughlin, ed.
(SY 64), 444 pp, hardcover, 2008
ISBN-13 978-1-934874-01-1
stock 540.64C
list price \$60
member price \$42

NEW

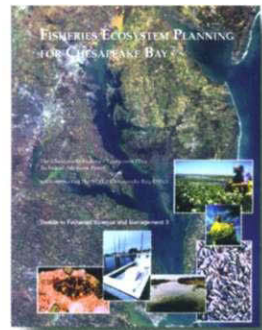
International Governance of Fisheries Ecosystems: Learning from the Past, Finding Solutions for the Future
Michael G. Schechter, Nancy J. Leonard, and William W. Taylor, eds.
450 pp est., paper, 2008
ISBN-13 978-1-888569-99-5
stock 550.56P
list price \$69
member price \$48



Salmon 2100: The Future of Wild Pacific Salmon
Robert T. Lackey, Denise H. Lach, and Sally L. Duncan, eds.

Restoring wild salmon to the Pacific Northwest is a daunting challenge. In this innovative book, 36 salmon scientists, resource managers, and policy experts identify realistic options to restore and sustain wild salmon runs in California, Oregon, Washington, Idaho, and southern British Columbia through this century. The policy prescriptions offered are candid, sometimes uncomfortably radical, and occasionally sobering. Most authors conclude that major, sometimes wholesale modification of core societal values and priorities will have to occur if significant, sustainable populations of wild salmon are to be present in the region through 2100.

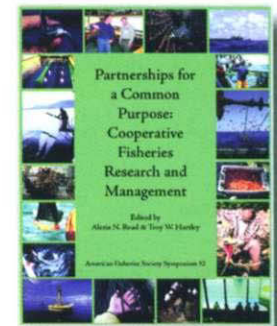
629 pp, hardcover, 2006
ISBN-10 1-888569-78-6
ISBN-13 978-1-888569-78-0
stock 550.50P
list price \$55
member price \$39



Fisheries Ecosystem Planning for Chesapeake Bay
NOAA Chesapeake Bay Fisheries Ecosystem Advisory Panel

Since European settlement, the Chesapeake Bay's estuarine system has supported major fisheries and the livelihoods of residents. Over recent decades, however, many of the fish and shellfish that supported these fisheries have declined. This work describes the structure and function of the bay's ecosystem, including key habitats and species interactions. Recommendations to implement ecosystem-based approaches to fisheries management for bay resident and coastal species are included, as well as recommendations for research to enhance knowledge of the ecosystem and its fisheries.

450 pp, paper, 2006
ISBN-10 1-888569-75-1
ISBN-13 978-1-888569-75-9
stock 550.51P
list price \$49
member price \$34



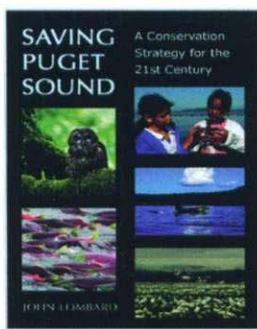
Partnerships for a Common Purpose: Cooperative Fisheries Research and Management
Alesia N. Read and Troy W. Hartley, eds.

Based on a September 2005 Sea Grant-sponsored AFS symposium, this book presents case studies, empirical research, and practical advice on innovative techniques used by cooperative partners working on cooperative fisheries research and/or management programs.

In addition to keynote speakers, the program incorporated panels consisting of an industry representative, a manager, a scientist, and a community participant. This format offered a broad range of perspectives, with panelists and keynote speakers selected for their many years of expertise and first-hand experience.

Participants discussed lessons learned, characteristics of successful programs, and future opportunities.

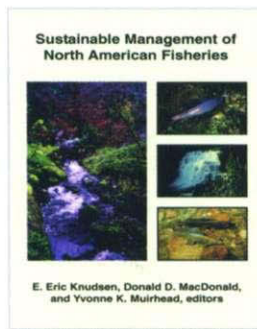
(SY 52), 270 pp, hardcover, 2006
 ISBN-10 1-888569-85-9
 ISBN-13 978-1-888569-85-8
 stock 540.52C
 list price \$60
 member price \$42



Saving Puget Sound: A Conservation Strategy for the 21st Century
 John Lombard

The National Academy of Sciences concluded that the "social structures and institutions" of the Pacific Northwest "have proved incapable of ensuring a long-term future for salmon." This topical book develops a practical proposal to conserve the Puget Sound region's most important ecosystems in the face of long-term population growth, drawing lessons that are relevant across the northwest and other parts of the country. In addition to salmon, Saving Puget Sound considers the rest of the region's natural heritage, including forests, rivers, Puget Sound itself and its shoreline, and distinctive habitats such as the south Puget Sound prairies.

336 pp, paper, 2006
 ISBN-10 1-888569-83-2
 ISBN-13 978-1-888569-83-4
 stock 550.52P
 list price \$35
 member price \$25



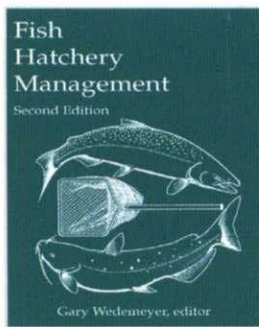
Sustainable Management of North American Fisheries

E. Eric Knudsen, Donald D. MacDonald, and Yvonne Muirhead, eds.

Fisheries throughout North America are faced with serious threats to their sustainability. Some of the key factors challenging fisheries sustainability include human population growth, overfishing, habitat alteration and destruction, water quality impairment,

aquacultural operations, introduction of alien species, and global climate change. New management approaches and institutional structures are needed that integrate economic, social, and environmental interests into a decision-making framework that supports fisheries sustainability.

(SY 43), 281 pp, paper, 2004
 ISBN-10 1-888569-65-4
 ISBN-13 978-1-888569-65-0
 stock 540.43P
 list price \$69
 member price \$48

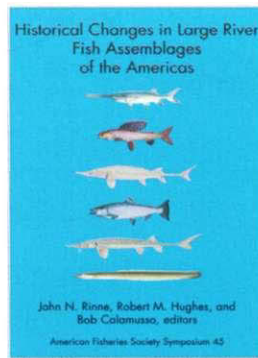


Fish Hatchery Management, Second Edition
 Gary A. Wedemeyer, ed.

This second edition expands and updates the original Fish Hatchery Management, the preeminent fish culture manual in North America since 1982, which has been used in universities and USFWS training centers nationwide to train new generations of culturists. The new edition has been completely rewritten by experts to include major advances in hatchery operation, in practical knowledge about raising high-quality fish, and in optimal use of cultured fishes in management programs. This up-to-date volume is greatly needed as a training tool and day-to-day hatchery resource. The new edition covers advances in production, water issues, transportation, stocking, open systems, controlled systems, semi-controlled systems, broodstocks and spawning, nutrition and feeding, fish health, and special considerations. Authors have developed chapters for relevance to both private and public fish culture.

Customers outside North and Central America order from: CABI Publishing, Nosworthy Way, Wallingford, Oxon OX10 8DE, United Kingdom
 733 pp, 2002
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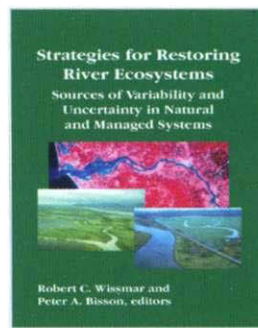


Historical Changes in Large River Fish Assemblages of the Americas
 John N. Rinne, Robert M. Hughes, and Bob Calamusso, eds.

Dramatic changes have occurred in the functioning of larger rivers because of social values and policies, land use, inchannel causes, and alien species. These changes have resulted in the reduction in range and abundance of many native fish species. This book describes the historical changes observed in the fish assemblages of 27 large rivers in North, Central, and South America. A synthesizing chapter highlights common and distinct patterns among the rivers and their stressors.

The book focuses on entire fish assemblages, including the many species that do not enter fisheries. It will be of interest to both fishery biologists and aquatic ecologists who are concerned with the status and trends in biodiversity and biointegrity. Includes historical information as well as new research and monitoring results, including research on metapopulations, genetics, and life history strategies.

(SY 45), 612 pp, paper, 2005
 ISBN-10 1-888569-72-7
 ISBN-13 978-1-888569-72-8
 stock 540.45P
 list price \$69
 member price \$48



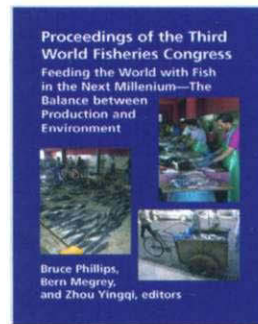
Strategies for Restoring River Ecosystems: Sources of Variability and Uncertainty in Natural and Managed Systems

Robert C. Wissmar and Peter A. Bisson, eds.

Fisheries and natural resource managers and policymakers need more efficient procedures for identifying sources of variability in ecosystems (natural and managed) and assessing uncertainties of managing and making decisions for developing and implementing river restoration strategies. This book seeks to integrate perspectives on variability

of physical and biological functions and concepts of uncertainty in natural and managed systems into strategies for renewing and conserving river ecosystems.

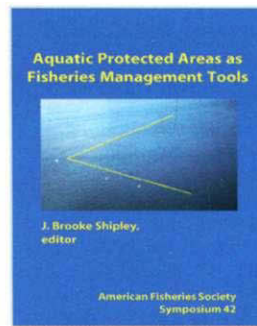
283 pp, paper, 2003
 ISBN-10 1-888569-46-8
 ISBN-13 978-1-888569-46-9
 stock 550.44P
 list price \$69
 member price \$48



Proceedings of the Third World Fisheries Congress: Feeding the World with Fish in the Next Millennium—The Balance between Production and Environment
 Bruce Phillips, Bernard A. Megrey, and Yingqi Zhou, eds.

Proceedings of the Third World Fisheries Congress, held in Beijing, demonstrating the potentialities and conditions for sustainable and steady development of the world fishing industry. The book presents information on 8 topics: (1) fish farming: past, present, and future; (2) aquafood: advances in seafood technology; (3) contribution of information technology to fisheries sustainability; (4) challenges in coastal zone management; (5) social and economic dimensions of fisheries; (6) can technology minimize the impacts of fisheries production; (7) biodiversity and fisheries production; and (8) paradigm shifts in fisheries management, assessment, and policy.

(SY38), 766 pp, paper, 2003
 ISBN-10 1-888569-55-7
 ISBN-13 978-1-888569-55-1
 stock 540.38P
 list price \$75
 member price \$53

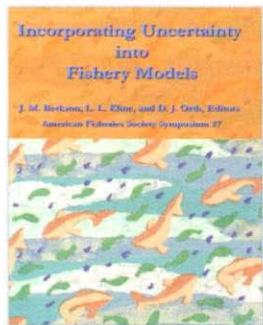


Aquatic Protected Areas as Fisheries Management Tools
 J. Brooke Shipley, ed.

The third volume in the AFS—Sea Grant series of symposia intended to develop new approaches to practical fisheries

management, this proceedings examines the highly discussed, studied, and debated topic of marine protected areas. Such protected areas are being looked upon as means to accomplish a variety of objectives including, but not restricted to, protection of fish stocks, control of fishing effort, protection of critical fish habitat, creation of spawning and recruitment refugia, and enhancement of species biodiversity.

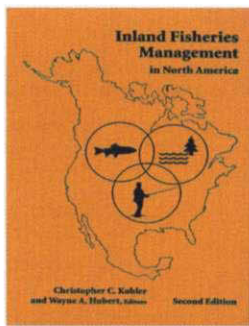
(SY42), 301 pp, paper, 2004
 ISBN-10 1-888569-62-X
 ISBN-13 978-1-888569-62-9
 stock 540.42P
 list price \$60
 member price \$42



Incorporating Uncertainty into Fishery Models
 Jim M. Berkson, Lisa L. Kline, Donald J. Orth, eds.

A valuable and much-needed reference, this book examines the full range of approaches for incorporating uncertainty or variability into fisheries work and ecosystem management. Until now, the dissemination of these methods, and their full range, has been slow and difficult, much to the detriment of management policies. This important book contains a series of new and original case studies with details of the context, purpose, methods, and results of each theoretical application. This practical information will enable readers to compare approaches and determine which one is most appropriate for their individual work.

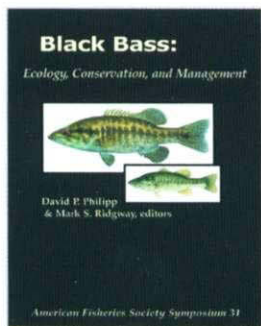
(SY27), 196 pp, paper, 2002
 ISBN-10 1-888569-31-X
 ISBN-13 978-1-888569-31-5
 stock 540.27P
 list price \$69
 member price \$48



Inland Fisheries Management in North America, Second Edition
 Christopher C. Kohler and Wayne A. Hubert, eds.

This revised edition updates a major college text and professional reference book. Authored by 42 eminent educators and fisheries managers, it reflects the rapid changes in managing inland fisheries since the first edition, especially in applying ecosystem approaches and adopting larger spatial scales for management. The book covers fishery assessments, habitat and community manipulations, and the common practices for managing stream, river, lake, and anadromous fisheries. Chapters on history, ecosystem management; management processes; communications with the public; introduced, undesirable, and endangered species; and the legal and regulatory frameworks provide the full context for modern fisheries management.

718 pp, hardcover, 1999
 ISBN-10 1-888569-13-1
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 member price \$55



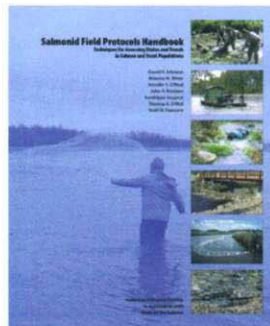
Black Bass: Ecology, Conservation, and Management
 David P. Philipp and Mark S. Ridgway, eds.

This book summarizes the proceedings of the symposium Black Bass 2000: Ecology, Conservation, and Management of Black Bass in North America held at the AFS Annual Meeting in St. Louis. The symposium was the largest gathering to date of fisheries science and management professionals with responsibility for black bass fisheries. The book represents the majority of contributions made by keynote, invited, and regular session presenters covering the areas of ecology, conservation, and management. Issues such as population regulation and recruitment, conservation genetics and

conservation of rare species, and new management approaches are all covered in this volume.

(SY31), 724 pp, hardcover, 2003
 ISBN 1-888569-38-7
 ISBN-13 978-1-888569-38-4
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METHODS

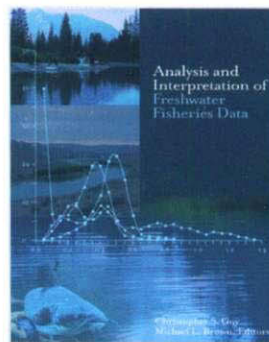


Salmonid Field Protocols Handbook: Techniques for Assessing Status and Trends in Salmon and Trout Populations
 David H. Johnson, Brianna M. Shrier, Jennifer S. O'Neal, John A. Krutzen, Xanthippe Augerot, Thomas A. O'Neil, and Todd N. Pearson

This is the first publication to collect, standardize, and recommend a scientifically rigorous set of field protocols for monitoring and assessing salmon and trout populations. Includes five additional techniques that can be used with any of the 13 principle methods to supplement information gathered.

Standardized monitoring protocols will improve data reliability, maximize opportunities for data sharing and data set comparability, and ultimately improve the ability to assess status and trends. The handbook will also support consistency in data collection for salmonids at the international level.

478 pp, paper, 2007
 ISBN-13 978-1-888569-92-6
 stock 550.55P
 list price \$35
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Analysis and Interpretation of Freshwater Fisheries Data
 Christopher Guy and Michael Brown, eds.

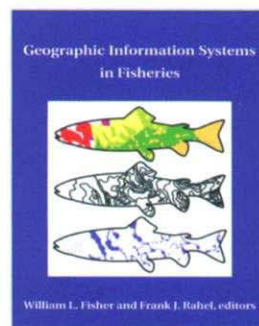
This long-awaited text is an excellent companion to AFS's *Fisheries Techniques* because it provides a frame of reference

for appropriate sample design, analysis, and interpretation of freshwater fisheries data. The chapters are organized by fish and fisheries data types, including recruitment, mortality, biotelemetry, habitat, and predator-prey interactions, within major topic areas, such as population dynamics, fish biology, and community assessment.

Chapters contain subsections describing the data type(s), indices, appropriate and alternative statistical approaches, applications, summary, and references. Statistical tests are nested within chapters to allow the reader to connect analyses to data types. Box examples allow the reader to easily follow the analysis method. The companion CD contains example data sets and programs so the reader can run the analyses, as outlined in the box examples.

The book is appropriate for advanced undergraduate and graduate students and is a practical resource for fisheries professionals. Includes a subject index and glossary.

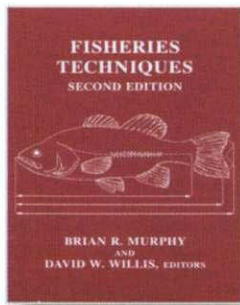
961 pp, hardcover, with CD-ROM, 2007
 ISBN-10 1-888569-77-8
 ISBN-13 978-1-888569-77-3
 stock 550.49C
 list price \$98
 member price \$69



Geographic Information Systems in Fisheries
 William L. Fisher and Frank J. Rahef, eds.

Geographic Information Systems (GIS) have an increasing number of significant applications in fisheries and aquatic science research and management. Yet, until now, little has been written on the subject. This new book is the first to concentrate on the unique challenges of using GIS to map and model fisheries and fish populations in aquatic environments. It is the first book of its kind that provides examples of GIS applications for all components of a fishery (i.e., organisms, habitats, and people), in both freshwater and marine environments. This important tool will serve as a reference for both fisheries and aquatic science students and professionals.

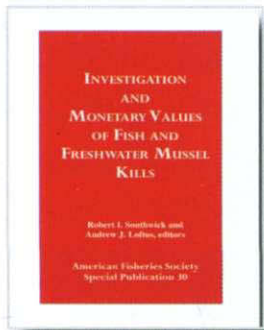
276 pp, hardcover, 2004
 ISBN-10 1-888569-57-3
 ISBN-13 978-1-888569-57-5
 stock 550.41C
 list price \$69
 member price \$48



Fisheries Techniques, Second Edition
Brian R. Murphy and David W. Willis, eds.

A comprehensive reference volume of modern sampling and data collection methods in fisheries science for students and professionals. This edition includes two new chapters: one on statistical considerations in fisheries sampling and the other on sampling of invertebrate organisms. All other chapters have been thoroughly rewritten to include innovations of the last decade.

732 pp, hardcover, 1996
 ISBN-10 1-888569-00-X
 ISBN-13 978-1-888569-00-1
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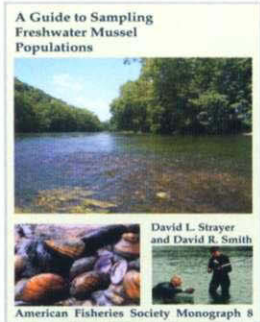


Investigation and Monetary Values of Fish and Freshwater Mussel Kills
Robert S. Southwick and Andrew J. Loftus, eds.

This book is an update and expansion of the widely accepted monetary values of fish that have been published by AFS since 1975 (last updated in 1992 as Special Publication 24). This publication has been adopted as the legal basis for restitution or fines in more than half the states and has been upheld in numerous legal challenges. In this current version, freshwater mussels are included for the first time. The publication contains comprehensive methods for assessing fish kills and freshwater mussel kill events and for assessing restitution based on replacement cost for organisms lost in the kill. Tables containing updated replacement cost values for most major fish species that are cultured and for all freshwater mussel species in the U.S. are included. This book is a must for anyone involved with fish or freshwater mussel kills, propagation, and water pollution policy.

BOOK AND CD
 (SP30), 177 pp, paper, 2003

ISBN-10 1-888569-48-4
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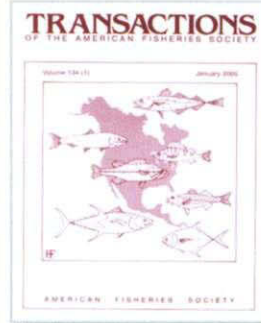


A Guide to Sampling Freshwater Mussel Populations
David L. Strayer and David R. Smith

Assessing mussel populations accurately and efficiently requires knowledge of both statistical principles and mussel biology. The purpose of this guide is to provide practical advice to environmental professionals to help them choose sound designs and methods for assessing freshwater mussel populations. The authors critically review sampling designs and methods that might be useful for sampling freshwater mussel populations and offer exemplary designs to meet several common objectives. The guide is largely compiled from published works, although some new, unpublished material is included, and brings together into a coherent, compact form the information needed to design mussel surveys and assessments.

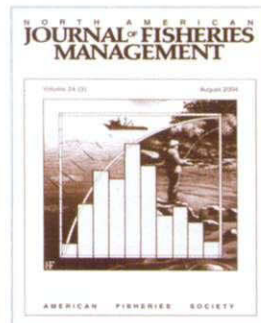
(M8), 103 pp, paper, 2003
 ISBN-10 1-888569-50-6
 ISBN-13 978-1-888569-50-6
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JOURNALS & MAGAZINE SUBSCRIPTIONS



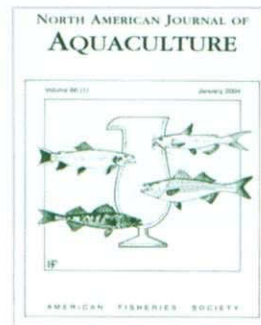
Transactions of the American Fisheries Society

R. J. Beamish, D. DeVries, and F.M. Utter, eds.
 Published bimonthly in paper and online formats. Available for AFS members.
 ISSN 0002-8487



North American Journal of Fisheries Management
C. A. Griswold, M. J. Hansen, and S. C. Riley, eds.

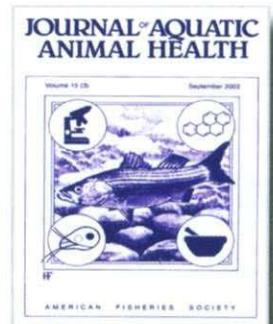
Published bimonthly in paper and online formats. Available for AFS members.
 ISSN 0275-5947



North American Journal of Aquaculture
B. A. Barton, W. L. Shelton, and C. C. Kohler, eds.

Published quarterly in paper and online formats. (Formerly published as The Progressive Fish-Culturist.)
 ISSN 1522-2055

	Nonmember	North America	International
paper	\$294	...	\$316
online	\$294	...	\$294
both	\$316	...	\$348



Journal of Aquatic Animal Health
V. S. Blazer, J. C. Wolfe, A. E. Goodwin, and C. M. Moffitt, eds.

Published quarterly in paper and online formats.

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INDEX

Advances in Fisheries Bioengineering.....	2	Historical Changes in Large River Fish Assemblages of the Americas.....	12
AFS Guide to Fisheries Employment, 2nd Edition.....	8	Hudson River Fishes and Their Environment.....	6
American Fisheries Society Slide Catalog, 5th Edition.....	8	Incorporating Uncertainty into Fishery Models.....	13
Anadromous Sturgeons: Habitats, Threats, and Management.....	11	Inland Fisheries Management in North America, 2nd Edition.....	13
Analysis and Interpretation of Freshwater Fisheries Data.....	13	Inland Fishes of Washington, Second Edition.....	9
Aquaculture in the 21st Century.....	5	International Governance of Fisheries Ecosystems: Learning from the Past, Finding Solutions for the Future.....	3
Aquatic Habitat Assessment: Common Methods.....	10	Introduction to Infectious Diseases of Salmonid Fishes.....	8
Aquatic Protected Areas as Fisheries Management Tools.....	12	Investigation and Monetary Values of Fish and Freshwater Mussel Kills.....	14
Aquatic Stewardship Education in Theory and Practice.....	7	Journal of Aquatic Animal Health.....	14
Behavior and Ecology of Pacific Salmon and Trout.....	9	Landscape Influences on Stream Habitats and Biological Assemblages.....	6
Benthic Habitats and the Effects of Fishing.....	10	Manual of Fish Culture.....	5
Bigheaded Carps: A Biological Synopsis and Environmental Risk Assessment.....	8	Mitigating Impacts of Natural Hazards on Fishery Ecosystems.....	3
Biological Indicators of Aquatic Ecosystem Stress.....	7	Monitoring Stream and Watershed Restoration.....	7
Biology, Management, and Protection of North American Sturgeon.....	6	Mysteries from the Yukon.....	8
Black Bass: Ecology, Conservation, and Management.....	13	North American Journal of Aquaculture.....	14
Black Carp: Biological Synopsis and Risk Assessment of an Introduced Fish.....	5	North American Journal of Fisheries Management.....	14
Bluegills: Biology and Behavior.....	5	Nutrients in Salmonid Ecosystems: Sustaining Production and Biodiversity.....	7
Burbot: Ecology, Management, and Culture.....	4	Partnerships for a Common Purpose: Cooperative Fisheries Research and Management.....	11
Catfish 2000: Proceedings of the International Ictalurid Symposium.....	6	Population Genetics: Principles and Applications for Fisheries Scientists.....	8
Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Cnidaria and Ctenophora, 2nd edition.....	10	Proceedings of the Third World Fisheries Congress: Feeding the World with Fish in the Next Millennium—The Balance between Production and Environment.....	12
Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Crustaceans.....	10	Propagated Fish in Resource Management.....	5
Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Mollusks, 2nd Edition.....	10	Reconciling Fisheries with Conservation: Proceedings of the Fourth World Fisheries Congress.....	4
Common and Scientific Names of Fishes from the United States, Canada, and Mexico, 6th Edition.....	9	Red Snapper Ecology and Fisheries in the U.S. Gulf of Mexico.....	2
Connecticut River Ecological Study (1965–1973) Revisited: Ecology of the Lower Connecticut River 1973–2003.....	7	Rotenone Use in Fisheries Management: Administrative and Technical Guidelines Manual.....	6
Development of Form and Function in Fishes and the Question of Larval Adaptation.....	5	Salmon 2100: The Future of Wild Pacific Salmon.....	11
Early Life History of Fishes in the San Francisco Estuary and Watershed.....	5	Salmonid Field Protocols Handbook: Techniques for Assessing Status and Trends in Salmon and Trout Populations.....	13
Ecology and Management of Wood in World Rivers.....	7	Salmonid Spawning Habitat in Rivers: Physical Controls, Biological Responses, and Approaches to Remediation.....	2
Ecology of Juvenile Salmon in the Northwest Pacific Ocean: Regional Comparisons.....	6	Saving Puget Sound: A Conservation Strategy for the 21st Century.....	12
Eels at the Edge: Science, Status, and Conservation Concerns.....	3	Shark Nursery Grounds of the Gulf of Mexico and the East Coast Waters of the U.S.....	9
Effects of Urbanization on Stream Ecosystems.....	10	Sockeye Salmon Evolution, Ecology, and Management.....	11
Fish Hatchery Management, 2nd edition.....	12	Status, Distribution, and Conservation of Native Freshwater Fishes of Western North America.....	8
Fisheries magazine.....	14	Strategies for Restoring River Ecosystems: Sources of Variability and Uncertainty in Natural and Managed Systems.....	12
Fisheries Ecosystem Planning for Chesapeake Bay.....	11	Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens (Blue Book) 2007 Edition.....	8
Fisheries in a Changing Climate.....	7	Sustainable Management of North American Fisheries.....	12
Fisheries, Reefs, and Offshore Development.....	10	Sustaining North American Salmon: Perspectives Across Regions and Disciplines.....	6
Fisheries Techniques, 2nd edition.....	14	Transactions of the American Fisheries Society.....	14
Fishes of Alaska.....	9	Whirling Disease: Reviews and Current Topics.....	5
Freshwater Fishes of Virginia.....	9		
Geographic Information Systems in Fisheries.....	13		
Grenadiers of the World Oceans: Biology, Stock Assessment, and Fisheries.....	2		
Guide to Sampling Freshwater Mussel Populations.....	14		

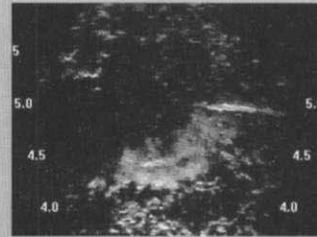
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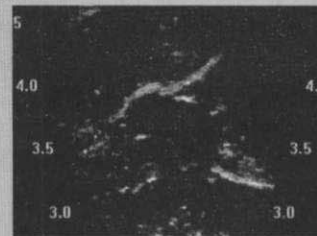
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