

# Preventing Lead Poisoning of Trumpeter Swans in Northwestern Washington

January 27, 2006

Tim Cullinan, Director of Science and Bird Conservation  
Audubon Washington  
1063 Capitol Way South, Suite 208  
Olympia, Washington 98507



©Jeff Larsen

## Problem and Solution

For the past six winters, an ever-increasing number of Trumpeter Swans in Whatcom County have died from lead poisoning. The birds are exposed to lethal levels of lead when they inadvertently ingest spent shotgun pellets while feeding in areas where the pellets have accumulated. Swan mortality from lead poisoning is growing despite the fact that lead shot for waterfowl hunting was banned in the United States 14 years ago (USFWS 2004a).

Representatives Brian Sullivan (D-21) and Jim Buck (R-24) introduced House Bill 2958 in the Washington State Legislature in January 2006. The intent of the bill is to further deter chronic repeat offenders of nontoxic shot rules established by the Washington State Fish and Wildlife Commission, and to encourage citizen reporting of such violators. Penalties under the bill include a one-thousand-dollar (\$1,000) fine and the loss of hunting privileges for two years.

## Lead in the Environment

**Legal and non-legal uses.** The traditional method for hunting wild birds is by shotgun, which fires a cluster of small metal pellets, called shot, at birds in flight (Figure 1). Through 1990 most shotgun shells used lead shot. A typical shot load for hunting ducks weighed 1.125 ounces and contained 225 0.11-inch-diameter lead pellets. A federal ban on lead shot for waterfowl hunting began in 1991, so most duck and goose hunters turned to non-toxic steel shot. While the ban also applied to hunting other aquatic birds such as coots, snipe, and rails, lead shot remained legal for hunting upland birds such as pheasants and quail (see below), and for target (skeet and trap) shooting. These legal uses continue to be a significant source of lead in some fields and wetlands.



Figure 1. Longitudinal section of a modern shotgun shell

**How and where lead accumulates.** When a shotgun shell is fired, only a small fraction of the shot strikes the target. The rest of the pellets fall back to earth, where the pellets accumulate in the soil either on land or on the bottom of wetlands or other water bodies. A 2001 report to the Washington Fish and Wildlife Commission estimated that each year more than 730 million lead pellets might be deposited statewide in the environment by upland game bird hunting (Washington Dept. of Fish and Wildlife Nontoxic Shot Working Group 2001).

Near waterfowl blinds or in agricultural fields where hunting activity is high, lead shot historically accumulated in substantial amounts. For example, an 85-acre pheasant-hunting site in the Skagit Wildlife Area was estimated to have 6.8 tons of lead shot in the

top four inches of soil. This amounted to an estimated 344,000 pellets per acre (Washington Dept. of Fish and Wildlife Nontoxic Shot Working Group 2001).

### **The Dangers of Lead for Birds**

**Birds' digestive systems.** Birds are poisoned when they ingest lead shot found in the soil or in wetlands. Because birds lack teeth, they swallow their food whole. Along with their food, birds swallow small pebbles, called grit, which grind the food in the gizzard. Aquatic birds, particularly ducks, geese, and swans, use the sensitive tissues in their bills to detect particles of food and grit in the soil or in mud at the bottoms of lakes and wetlands – but waterfowl are unable to distinguish lead shot from pebbles, and may also ingest the toxic lead pellets.

**Lead's deadly effects.** Lead pellets enter the gizzard, where they are ground into smaller particles and partially dissolved by digestive acids. The dissolved lead combines with other elements in the bird's digestive tract and is absorbed into the bloodstream, where it inhibits the ability of hemoglobin to carry oxygen, and reduces the number of red blood cells. Depending on the dose of lead, it may take only a few days for the bird to experience anemia, and its muscles weaken. If the anemia is severe enough, the bird may lack the strength to eat, and slowly starve to death or die from the failure of vital internal organs (Bellrose 1975), or from neurological damage. Furthermore, weakened birds are more vulnerable to accidents, hypothermia, and predators, so their ability to survive is reduced even if the dose of lead itself is not lethal.

**Toxic doses and wildlife mortality.** Lead is extremely toxic if eaten and absorbed into the blood. Symptoms of lead poisoning can appear as soon as four days after ingestion of as few as two to three pellets, with death occurring in 17 to 21 days. A single pellet has been shown to be lethal to birds as large as swans. Controlled studies conducted in the 1950s showed that ducks that ingested four 0.11-inch-diameter lead shot pellets suffered a mortality rate 41% higher than those that were free of lead (Bellrose 1975). The Canadian Wildlife Service estimated that 250,000 waterfowl died per year from lead poisoning in Canada (Scheuhammer and Norris 1995). It estimated that several million more waterfowl suffer sub-lethal effects, resulting in lower survival rates and reduced breeding success. Before the 1991 prohibition on lead shot for waterfowl hunting, it was estimated that two to three percent of the autumn and winter populations of waterfowl across the U.S. fell victim to lead poisoning each year (Bellrose 1976, p. 73).

Lead shot in the environment also causes secondary poisoning of wildlife. This may happen when scavengers or predators such as owls, hawks, and eagles ingest lead while feeding on prey containing lead pellets, or on prey with lead-contaminated muscles and internal organs. The high number of endangered Bald Eagles lost to secondary lead poisoning in the 1970s was one of the primary reasons for the federal ban on lead shot for waterfowl hunting.

**Restrictions and results.** Lead poisoning of waterfowl from the ingestion of shot was recognized as early as 1901 (Schillinger and Cottam 1937). The first calls for reduction of lead shot came in the 1950s, but more than 20 years passed before there was general consensus among wildlife professionals that a partial ban should be implemented. The United States banned lead shot for waterfowl hunting in 1991. Canada followed with a ban in 1999. Steel shot is the most widely used alternative to lead, but because of its lighter weight, some hunters do not like it as much. Recently, ammunition manufacturers have begun offering shotgun loads made with heavier non-toxic metals such as bismuth, tin, or tungsten alloys, which have ballistic properties similar to lead. While a full discussion of alternatives to lead shot is beyond the scope of this paper, more information can be found at <http://wdfw.wa.gov/wlm/game/water/nontoxicshotfinal.htm>.

Again, the federal ban on lead shot applies only to hunting waterfowl and other aquatic game birds. Lead shot is still legal for hunting upland game and for target shooting. However, because of the behavior and ecology of most upland species and the methods used to hunt them (hunters are more widely dispersed and fewer shots are taken), less shot is deposited and is more widely distributed than in waterfowl hunting. In general, lead deposition in uplands is considered a less serious threat to wildlife than in bodies of water – however, some exceptions exist. For example, in areas with intensive hunting activity, such as fields managed for Mourning Dove hunting or in public hunting areas where pheasant populations are augmented by stocking farm-raised birds, lead shot deposition may reach dangerously high levels. Concerns about excessive lead deposition led the Washington Fish and Wildlife Commission in the year 2000 to adopt a ban on lead shot for all hunting on all or parts of eleven public hunting areas comprising 20,000 acres.

Reduction in the use of lead shot has shown positive impacts on waterfowl populations. A study conducted in the Midwest concluded that by 1997, approximately 1.4 million ducks per year (Anderson et al. 2000) had been saved by the ban. The same study concluded that only about 1.1% of the ducks examined showed evidence of being shot with lead, indicating that the vast majority of hunters in the Midwest were observing the ban. This level of compliance, however, has not been achieved in Washington or British Columbia (see below).

### **Lead Poisoning of Swans in Washington**

**Toxic shot research.** Between 1999 and 2005 at least 1,714 dead Trumpeter and Tundra Swan were found and studied in Whatcom and Skagit Counties and on the adjacent Sumas Prairie in British Columbia (USFWS 2004, Smith 2006) (Figure 2). Most of these were Trumpeter Swans that roost on Judson Lake, a shallow, seasonally flooded, 100-acre lake that straddles the U.S.-Canadian border about 18 miles east of Blaine, and several other shallow lakes in Whatcom County (Fountain, Fason, and Wiser Lakes). Analysis estimated that at least 70% of these swans were killed by lead poisoning, caused by ingestion of toxic shot pellets in the fields and shallow lowland waters.

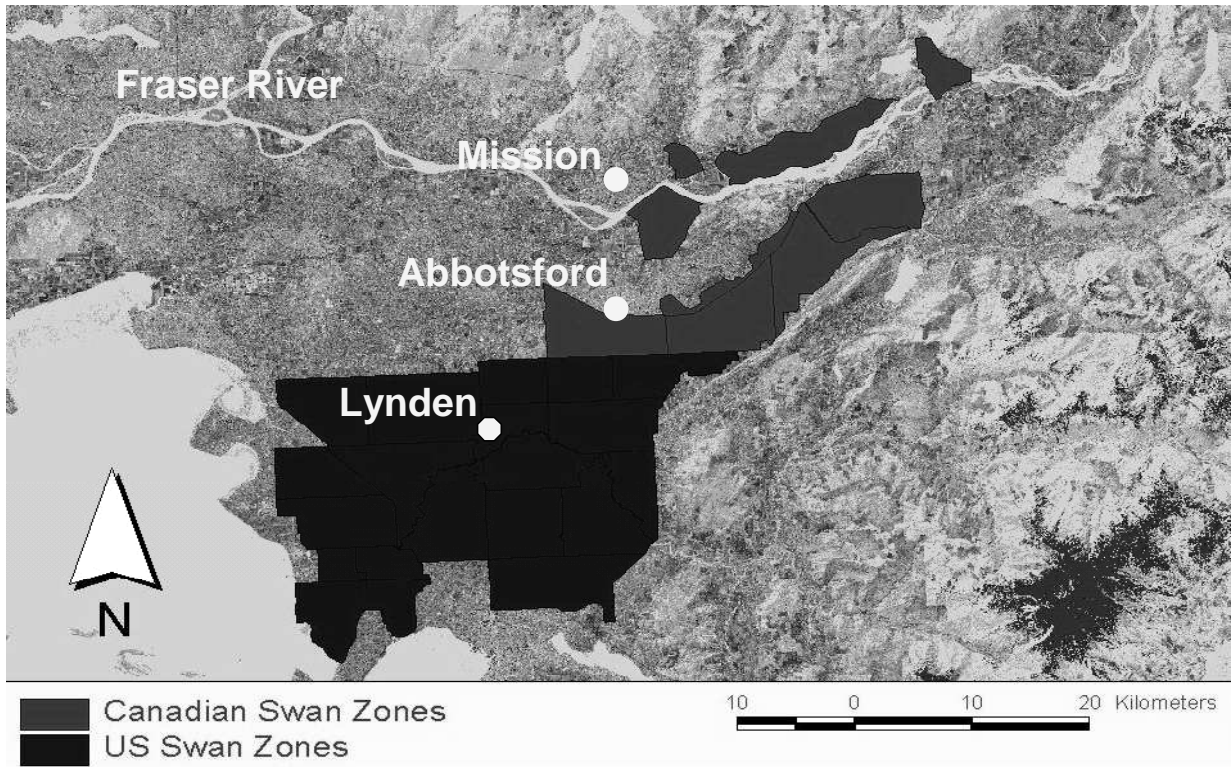


Figure 2. Range of wintering Trumpeter Swans in Whatcom County and southern British Columbia. Map from Smith 2006.

Proven swan mortality in these areas reached as high as 400 deaths in a single year (Table 1). This amount, however, is probably lower than the actual number because the carcass count included only those still in sufficiently good condition to be analyzed for cause of death. The mortality count did not include dead swans that were consumed or dragged away by scavengers (e.g. coyotes), which leave only a cluster of feathers that cannot be analyzed for the presence of lead. In 2005, for example, 307 carcasses were collected, but an additional 24 swans were known to have died in Whatcom County alone, based on counts of remains. Furthermore, it is highly likely that no trace is ever found of some carcasses. Consequently, the true toll is thought to be 15% to 20% higher than the number collected for analysis (Michael Smith, University of Washington, personal communication). If so, then actual mortality could exceed 450 swans in some years.

Since 1999 wildlife scientists have conducted necropsies on dead swans to determine levels of lead ingestion. Results for the first four years indicate that more than 92% of the mortalities have been Trumpeter Swans, 5% Tundra Swans and the remainder undetermined. The average number of lead pellets per gizzard was 22, with a maximum of 378. The average number of non-toxic pellets was eight – but the number ranged upward to a maximum of 309. Four percent of the swan gizzards analyzed contained more than 100 lead shot pellets. Most of these were found at Judson Lake. More than

20% of swans tested in northwest Washington had elevated levels of lead in their internal organs. Two percent of the birds tested had lethal levels of lead (Smith 2006).

Table 1. Swans collected during major mortality events over the past six winters in Washington State and British Columbia. Table from Smith 2006.

<b>Year</b> <sup>(a)</sup>	<b>Washington State</b> <sup>(b)</sup>	<b>British Columbia</b> <sup>(c)</sup>	<b>Total</b>
1999-2000	71 <sup>(d)</sup>	23	94
2000-2001	171	139	310
2001-2002	204	160	364
2002-2003	144	93	237
2003-2004	246	156	402
2004-2005	241 <sup>(e)</sup>	66	307

<sup>(a)</sup>November through March

<sup>(b)</sup>Includes Whatcom, Skagit & Snohomish Counties of Washington State

<sup>(c)</sup>Includes Sumas Prairie in British Columbia

<sup>(d)</sup>Represents only a portion of actual die-off as collection did not begin until Jan. 2000

<sup>(e)</sup>Includes all collections on Judson Lake spanning the US/Canada border, US collected swans from entire lake to reduce redundant efforts

**Trumpeter Swan mortality in the Northwest.** The Trumpeter Swan is America’s largest bird, weighing up to 30 pounds and with a wingspan of seven feet (Palmer 1976). At one time threatened with extinction, the Trumpeter Swan has made a remarkable recovery in the past 50 years. Still, the entire global population of this bird was estimated to number only about 23,600 in 2002 (USFWS 2003). The Pacific Northwest is an important wintering area for Trumpeter Swans, with about one-sixth of the entire world population spending the winter in the Puget Sound lowlands in Skagit and Whatcom counties, as well as in southern British Columbia. The primary cause of mortality for this important wintering population is poisoning from the ingestion of lead shot (USFWS 1994b). Given the small population of Trumpeter Swans (by contrast, there are five million Canada Geese in North America), the possible loss of 300 to 400 individuals per winter from lead poisoning alone raises great concern.

Most Trumpeter Swans that winter in Washington breed in Alaska (Mitchell 1994) (Figure 3), and arrive in our state in early to mid-November. Most of the lead poisoning mortality occurs in late December and early January. Since it’s estimated that lead shot takes about 30 days to kill a Trumpeter Swan, the timing of the Washington population’s mortality indicates that the birds ingest the lead after they arrive in their wintering areas and not during migration.

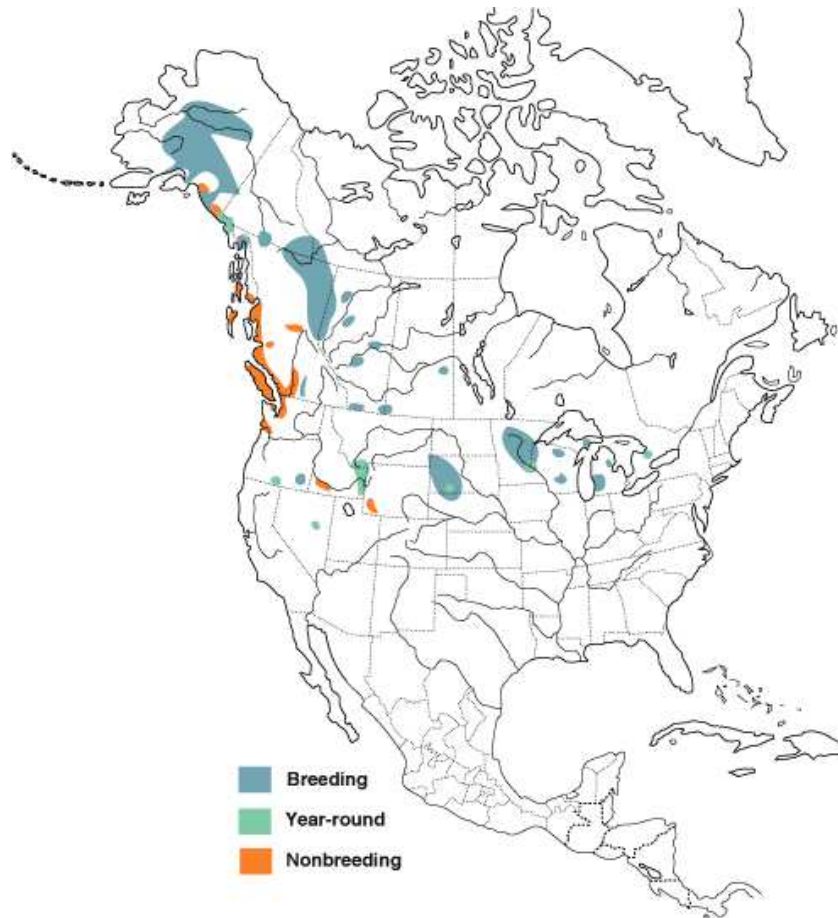


Figure 3. Range of the Trumpeter Swan in North America. From Mitchell 1994

### Efforts to Reduce or Prevent Lead Poisoning in Trumpeter Swans

**Sources of lead?** It is not known exactly where the swans in Northwestern Washington are ingesting lead, or what the source of the lead might be. Currently there are three hypotheses:

- First, it may be that the swans are eating old lead pellets left from decades of hunting over the waters and fields where the swans roost and feed
- Second, the lead may be coming from illegal use of lead shot in waterfowl hunting in and around the lakes where the swans roost, particularly Judson Lake
- Third, the swans may be ingesting recently deposited lead shot while foraging in the uplands, perhaps in fields with heavy lead content in the soil from concentrated hunting or shooting activity.

**Old lead pellets.** In winter, Trumpeter Swans forage extensively in pastures and agricultural fields, grazing on grasses and forbs, and eating residual agricultural crops such as corn and potatoes (Anderson 1993). When feeding in fields with high levels of lead lying close to the surface, swans inevitably ingest some of the lead shot. The

Washington Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, and the Canadian Wildlife Service are conducting research to identify areas of lead-shot contamination and to prepare a clean-up plan. More than 200 swans have been fitted with radio transmitters, and telemetry monitoring has narrowed down the search for the contaminated sites to a few “areas of interest” comprising about 650 acres. Soil sampling to detect lead contamination is being conducted this winter on as many as 500 of these acres.

**Illegal use of lead shot.** It is also possible that swans are ingesting recently deposited lead from the continuing illegal use of lead shot by some waterfowl hunters. As noted above, it has been illegal to use lead shot for waterfowl hunting in the U.S. since 1991. Compliance with this ban in Washington has not been as high as in other parts of the United States. The Washington Department of Fish and Wildlife reports an eight percent “chronic repeat offender” rate among waterfowl hunters in Washington (Bruce Bjork, Enforcement Chief, Washington Department of Fish and Wildlife, personal communication January 2006). This doesn’t necessarily mean that eight percent of the shot used in waterfowl shooting is lead, as the definition of non-compliance includes mere possession of shells containing lead shot while waterfowl hunting, even if those shells aren’t being fired. Nevertheless, it is estimated that one to two percent of the shot spent in waterfowl hunting is lead (Washington Department of Fish and Wildlife, Division of Law Enforcement). In Canada, the illegal use of lead shot appears to be greater. The Canadian Wildlife Service enforcement division estimates that in 2005 about 15% of the shot spent around Judson Lake was lead. House Bill 2958 was introduced to address the problem of illegal use of lead shot in Washington.

**Ongoing deposition of lead shot in uplands.** It is legal to use lead shot when hunting upland game such as quail and pheasants. Although upland hunting is usually more dispersed than waterfowl hunting, there may be places where concentrated upland hunting activity is causing large amounts of lead to be deposited in the soil. Alternately, there may be areas where trap and skeet shooting are resulting in elevated lead levels in upland areas. Because swans often feed in upland agricultural fields, they may be exposed to high levels of lead if their foraging areas overlap areas of concentrated hunting or shooting. The telemetry research described above will help to determine if the continuing use of lead shot in the uplands is a significant source of lead ingested by swans.

**Protective actions.** It is likely that all three hypotheses about the sources of the lead are correct to some degree. To rectify this situation, a coalition of conservation groups including hunters, academic institutions, and government agencies are taking action to reduce the amount of lead exposure to swans and other wildlife. Sites with a high concentration of residual lead shot will probably require clean up and remediation, with highest priority for corrective action given to sites where lead exposure is greatest.

To reduce the continuing deposition of lead resulting from upland game hunting, the Trumpeter Swan Society and Audubon Washington are conducting outreach efforts to hunters and shooters to inform them about the dangers of lead, and to encourage them to

use non-toxic shot wherever possible. These outreach efforts include presenting programs at meetings of hunters and hunter safety instructors, and distributing wallet-size informational cards to hunters at fairs and outdoor shows (Figure 4).

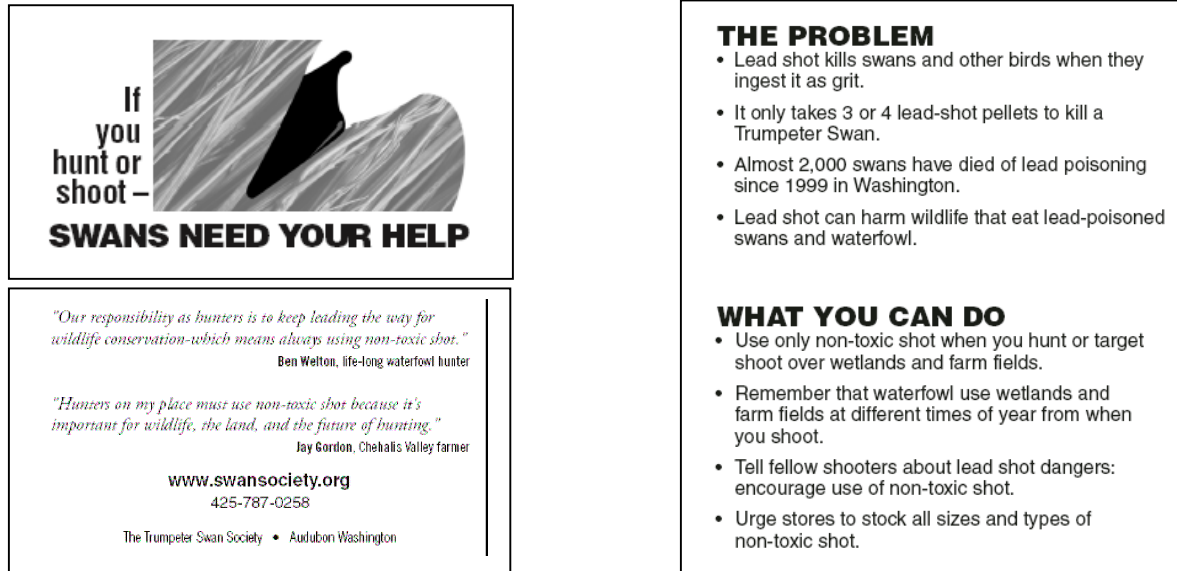


Figure 4. Examples of outreach material distributed by conservation groups to encourage the voluntary use of non-toxic shot in upland hunting and shooting.

**Legislative help for swans.** There is a need to further reduce or eliminate the illegal use of lead shot in waterfowl hunting. As a first step, the Washington Department of Fish and Wildlife, wildlife conservation groups, and hunting organizations are proposing legislation to improve enforcement of the ban on the use of lead shot, and to increase penalties for violations of the ban. As in the case of any environmental contaminant, the cost of prevention is vastly lower than the cost of remediation.

House Bill 2958, penalizing persons who violate rules concerning the use of nontoxic shot, was introduced in the Washington State Legislature by Representatives Brian Sullivan (D-21) and Jim Buck (R-24) in January. The intent of the bill is to further deter chronic repeat offenders of nontoxic shot rules established by the Washington State Fish and Wildlife Commission and to encourage citizen reporting of such violators.

When passed, the new law will require courts to impose a one thousand dollar (\$1,000) criminal wildlife penalty on persons convicted of violating a rule adopted by the Fish and Wildlife Commission mandating the use of nontoxic shot. The penalty revenue will go to the fish and wildlife enforcement reward account, to reward citizens for reporting violations of such rules. The Department of Fish and Wildlife will also revoke the hunting license of the person and order a suspension of small game hunting privileges for two years.

**Acknowledgements:** The author gratefully acknowledges the contributions of the Trumpeter Swan Society, the Washington Cooperative Fish and Wildlife Research Unit, and the Washington Department of Fish and Wildlife, all of whom provided information for this paper, or assisted with review and editing. Audubon Washington also thanks its anonymous donor for supporting protection of estuarine and coastal bird habitat; and Cristina Craft for the use of her photograph of Trumpeter Swans.

### Literature Cited:

- Anderson, P.S. 1993. Distribution and habitat selection by wintering Trumpeter Swans *Cygnus buccinator* in the Skagit Valley, Washington. Master's Thesis, University of Washington, Seattle.
- Anderson, W.L., S.P. Havera, and B.W. Zercher. 2000. Ingestion of lead and nontoxic shotgun pellets by ducks in the Mississippi flyway. *Journal of Wildlife Management* 64(3): 848-857.
- Bellrose, F. 1975. Impact of ingested lead pellets on waterfowl. pp. 633-641 in Ratti, J.T., L.D. Flake, and W.A Wentz (eds.). 1982. *Waterfowl ecology and management: selected readings*. The Wildlife Society Inc. Bethesda, MD. 1328 pp.
- Bellrose, F. 1976. *The ducks, geese, and swans of North America*. Stackpole Books. Harrisburg, PA. 540 pp.
- Mitchell, C. D. 1994. Trumpeter Swan (*Cygnus buccinator*). In *The Birds of North America*, No. 105 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Palmer, R. S. ed. 1976. *Handbook of North American Birds Vol. 2 Waterfowl (Part 1)*. Yale University Press. 520 pp.
- Scheuhammer, A. M., and S. L. Norris. 1995 A review of the environmental impacts of lead shotshell ammunition and lead fishing weights in Canada. *Canadian Wildlife Service. Occasional Paper No. 88*.
- Shillinger, J.E. and C.C. Cottam. 1937. The importance of lead poisoning in waterfowl. Pp. 628-632 in Ratti, J.T., L.D. Flake, and W.A Wentz (eds.). 1982. *Waterfowl ecology and management: selected readings*. The Wildlife Society Inc. Bethesda, MD. 1328 pp.
- Smith, M. 2006. 2001-2005 Swan Lead Mortality Project Report. Washington Cooperative Fish and Wildlife Research Unit. University of Washington, Seattle. 36 pp.

USFWS. 2003. North American Waterfowl Management Plan, 2003 Draft. U.S. Department of the Interior, Washington, D.C. 126pp.  
<http://birdhabitat.fws.gov/NAWMP/2003nawmpdraft.htm>

USFWS. 2004a. Trumpeter Swans lead poisoning mortality investigation: progress report 2004. U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office. Olympia. (<http://www.fws.gov.westwafwo/ie/leadpois.pdf>)

USFWS. 2004b. Trumpeter Swans in Washington. U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office. Olympia.  
(<http://www.fws.gov.westwafwo/ie/Swan.pdf>)

Washington Department of Fish and Wildlife Nontoxic Shot Working Group. 2001. Report to the Washington Fish and Wildlife Commission: The use of non-toxic shot for hunting in Washington. Draft 11/1/01. Washington Department of Fish and Wildlife. Olympia. 18 pp. (<http://wdfw.wa.gov/wlm/game/water/nontoxicshotfinal.htm>)