CALIFORNIA CONDOR FOOD AND FORAGING

IN NORTHWESTERN NORTH AMERICA

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ABSTRACT--The historical foraging niche of California Condors *Gymnogyps californianus* in Oregon, Washington, Idaho, Montana, Alberta and British Columbia is described from 25 foraging observations. Association of condors with humans and poisoning as the major cause of condor population decline are evaluated. Toxins in foraging habitats need to be eliminated before condors are released in the Pacific Northwest.

Keywords: California Condor, *Gymnogyps californianus,* northwestern North America, diet, foraging, poisoning.

Successful foraging is essential to the survival and recovery of endangered, threatened, and declining species. Attempts to reintroduce California Condors *Gymnogyps californianus* to the wild in California and Arizona have had limited success. Contaminated foraging habitat, more than any other factor, resulted in excessive mortalities (47%) and populations unable to sustain themselves without continuous release of captive-reared birds (www.arizonaes.fws.gov; www.dfg.ca.gov; Cade 2007).

Historically, condors inhabited northwestern North America as well as California and Baja California (Koford 1953; Wilbur 1973). Historical and new information of their status and year-round distribution in the Northwest were compiled and analyzed by Sharp (2008). If condors were reintroduced in the Northwest, their management, to be successful, would require an understanding of condor food and foraging ecology. Ecological information on foraging of condors in northwestern North America is almost non-existent. In California where condors have been studied, "One of the weakest aspects of condor studies in the 1980's was a failure to gain truly comprehensive [unbiased] data on the diet" (Collins and others 2000; Snyder and Snyder 2000 p. 152).

The present paper analyzes historical observations of condor foraging in the Northwest, to determine, preliminarily, the food base historically utilized by condors, and thereby learn something of their ecology. The analysis also examines whether after European settlement the foraging niche sustained the northwestern condor population or whether it was the probable cause of its extinction.

METHODS

The area studied includes Oregon, Washington, Montana, and Idaho in northwestern United States and British Columbia and Alberta in western Canada. Information gathered on foraging California Condors was gleaned from published and unpublished observations associated with specimens, sight records, and Native American oral history.

Criteria for deciding whether observations used in this study pertain to condors are described in detail in my paper on "California Condors in Northwestern North America" (Sharp 2008). They include: whether the birds were well-seen, whether characteristic details (size, coloration, or behavior) were provided, observer's competence and familiarity with the species, observer familiarity with other species with which condors could be confused, details having to do with time and place of the observation, and combinations thereof. Possible confusion with Turkey Vultures *Cathartes aura* was of particular concern. Condors and *Cathartes* were differentiated by comparing appearance, known distribution of *Cathartes*, and foraging profiles. The latter seem to be non-overlapping in several respects, for example, *Cathartes* "Although prefers relatively fresh carrion...cannot open thick skin, so must wait until large carcass is putrid or is opened by mammals or larger vultures" (Kirk and Mossman 1998); condors appropriate game freshly-killed by hunters, and also feed on human carcasses, whereas *Cathartes* cannot, do not, or there is no record of them having done so (Lewis and Clark 1990; Harris 1941; Snyder and Schmitt 2002).

Data extracted from each observation included kind of food item, foraging circumstance,

behavior, place, date or season, and observer. General statements about condors eating "carrion" were not useful and omitted. The data in this study are integrated with data from California to develop a context for understanding the ecological niche and reasons for the decline of California Condors in northwestern North America.

RESULTS

Approximately 100 observations of condors in the six states and provinces of the study area were available for examination (Sharp 2008). Of these, 25 provided information on food or foraging. The data are summarized in Table 1, and details are provided in Appendix A.

The 25 records indicate that condors in the Northwest foraged along fresh and salt-water shorelines on fish and marine mammals, in riverine riparian habitat on Columbian white-tailed deer *Odocoileus columbianus* and humans *Homo sapiens*, in forested and cleared uplands on big game and domestic animals, and on bison *Bos bison* in grassland. Because rivers were an historic route for travel and trade, and the location of native and European settlements, observations in aquatic habitats are probably over-represented. That condors were encountered foraging in probably under-represented upland habitats is thus noteworthy.

Sample sizes are small for categories of food items summarized in Table 1, and the data may be biased for that reason. However, they begin to outline some of the components of the foraging profile of condors in the Northwest. Of 25 foraging observations, the highest number (n=6) were of salmon, either live, dead, or as offal. The second highest category (n=4) was of condors observed appropriating hunter-killed deer *Odocoileus* sp. or elk *Cervus canadensis*,.

The observation of condors eating “wild cranberries” is intriguing (Appendix A). Koford (1953 p 59) observed condors eating leaves and examined condor pellets consisting entirely of vegetation, but there was no mention of condors doing so in Snyder and Schmitt (2002). Turkey and Black vultures are known to eat fruits (Kirk and Mossman 1998; Buckley 1999).

Condors associated with humans in 60% of observations (15 of 25). Condors' feeding on bison in Montana hunted by pre-contact prairie native peoples was apparently commensal, as no observations have surfaced of condors feeding on bison on their own. Records of condors east of the Rockies ceased after the last Blackfoot bison drives in 1872 and the extermination of bison during the following 10 years (Ewers 1949). On the Columbia River and tributaries, Townsend

noted that condors were “met with near the Indian villages, being attracted to the offal of the fish thrown around their habitations” (Audubon 1839). Condors were attracted by and appropriated big game that hunters killed, cached, or crippled (Lewis and Clark 1990 vol 7 p 25; Ordway 1916 p 366; Lewis and Clark 1990 vol. 8 p 22-23); in the winter of 1805-1806 at Fort Clatsop on the Columbia estuary, the Lewis and Clark party consumed 131 elk and 20 deer between 1 Dec and 20 March (Gass 1904 p 169), and crippled many more (cf Lewis and Clark 1990 vol. 8 p 22-23) . Condors frequented camps of fur traders on the Columbia River in the early 1800s: A Henry wrote, “Some extraordinarily large vultures were hovering over camp” and noted them discovering and appropriating cached deer (Coues 1897 pp 808, 817). Condors were reported on more than one occasion in landscapes burned by Indians in Oregon west of the Cascades (Douglas 1959; Peale 1848), a practice which have benefited condors.

Condor-human relations included 2 records of condors feeding on human beings, *Homo sapiens*, the individual slaves of Indians and later, during epidemics, inhabitants of entire villages (Table 1, Appendix). Human beings have not been mentioned as a component of the condor foraging profile in other studies (Koford 1953; Collins and others 2000; Snyder and Schmitt 2002).

Two records refer to condors having apparently been poisoned (Putnam 1928; Wilcox 1918). The issues raised by those accounts are discussed below.

Two foraging observations from the Northwest suggest that condors can smell. G Barnston, Hudson's Bay Company clerk at Fort Vancouver, wrote, “It has been frequently a matter of surprise how quickly these birds collect when a large animal dies. None may be seen in any direction, but in a few minutes after a horse or other large animal gives up the ghost they may be descried like specks in the ether, nearing by circles to their prey, when as yet one would not

suppose the effluvia from the carcase (sic) had reached above a hundred yards. This renders it probable that their sight as well as their sense of smelling is very acute, but that the latter can guide them entirely without aid from the other, I am certain, as I have started them from carrion within the edge of the forest under bushes which must have precluded the possibility of their seeing the carcase before they alighted on it" (Fleming 1924). Douglas (1829) also wrote that "Their senses of smelling and seeing are remarkably keen", an observation that either derives from or is independent of Barnston's. A Henry noted on 25 Jan 1814, that near the Pudding River (tributary to the Willamette River), "I sent for the eight deer killed yesterday. The man brought in seven of them, one having been devoured by the vultures. These birds are uncommonly large and very troublesome to my hunters, by destroying the meat, which, though well covered with pine branches, they contrive to uncover and devour." (Coues 1897 p 817).

DISCUSSION

The historical observations of foraging by condors presented here are the only data available specific to the Pacific Northwest. They are certainly not more representative of what condors actually select during foraging than studies in California before radio-tagging became standard (Collins and others 2000; Snyder and Snyder 2000). The data are sufficient to begin to draw some ecological inferences on diet, which have management implications.

Association between condors and humans

Though probably biased, the relationship between condors and humans seems real. Observations of condors associating with humans in the Northwest are replicated by similar observations in California, of condors unafraid of humans, tame, inquisitive, foraging near buildings (Harris 1941; Koford 1953; Wilbur 1978 p. 35; Snyder and Rea 1998 p 35). J Ogden watched condors "shadowing" deer hunters during the hunting season in the 1980s (Nielsen 2006 p 163). Other vulture species known to associate with humans are Cineraceous Vultures *Aegypius monachus* in Mongolia “soon put in an appearance after a rifle shot” (Meyburg and Meyburg 1983), and Black Vultures, which are legally protected in Venezuela for their usefulness in disposing of human garbage (Pedro Bichier, Smithsonian Research Biologist, pers. comm.). Resting from a strenuous climb in the Andes, Peale (1848) was approached by an Andean Condor *Vultur gryphus* as if his physical condition was being assessed. Fermor (1992 p 30) noted, “The [Andean] Condor... The vast creature swooped and hovered several times during the day, or floated *like a spy"* (my emphasis). Abyssinian armies sweeping through an area left tremendous numbers of carcasses of men and animals (Schuez and Koenig 1983): "When an army is on the march the birds form a dense roof above them stretching for several miles, and when the army moves into camp the ground as far as the eye can see is completely covered by them." Until recently vultures acted as undertakers in human burials in Bulgaria, and in Tibet and India still do (ibid.).

The condor-human association was obviously advantageous to condors before European contact; the behavior developed and was probably naturally selected for over many generations and thousands of years. After Europeans introduced lead ammunition and poisons for predators and rodents in the 1800s, the association and the behavior became maladaptive. The large predators,

grizzly bears *Ursus horribilis*, wolves, and cougars *Felis concolor*, were the targets of poisons in the 1800s. In the present day, coyotes *Canis latrans* and ground squirrels *Spermophilus* sp. are poisoned in large numbers by federal, state and local agencies (pers. obs.), and condors feeding on carcasses of hunter-killed deer and elk, on carcasses of domestic animals laced with poison, and on poisons for predators and rodents distributed in the form of poison baits, are at risk of incidental poisoning.

The notion that condors are a wilderness species needing isolation from human beings is inconsistent with the available data. The misunderstanding was catastrophic, and resulted in a hands-off attitude towards condor management from the late 1930s to the mid-1980s precisely when active protection of the few remaining condors from the lethal effects of unseen contaminants became an absolute management necessity. Leaving condors alone translated directly into continuing, and unsustainable, mortalities from poisonings (Snyder and Snyder 2000; Cade 2007). That condors' association with humans was an integral part of their formerly adaptive but later dysfunctional foraging niche also implies that the attempt to prevent condors from associating with humans is impractical and would require changing the characteristics of the species (Deblieu 1991 p 216).

Sense of smell

Observations in the Northwest in this study that suggest that condors are able to smell (Fleming 1924; Douglas 1829; Coues 1897 p 817) are supplemented by observations in California (Harris 1941). They are also consistent with Stager's (1964) finding, based on the dissection of a slightly

damaged condor specimen, that the external nares and olfactory tubercle of California Condors are as large as in *Cathartes*, and also, although not as large as *Cathartes,* the presence of a distinct olfactory bulb. The account by Demers and others (1956 p 180) in 1843, received from on Indians of the lower Columbia River, that "the Vulture, said to be from California, a bulky black bird, very voracious, [was] noted for the keenness of its sense of smell", indicates that a vulture species they were familiar with, probably the condor, had a sense of smell (Sharp 2008, Appendix).

Given the importance of understanding its basic biology to condor recovery, it seems surprising that olfaction in condors has not been proven conclusively nor been convincingly dismissed. The management implications are significant. If condors have an olfactory capability, even if limited, the use of scent to attract predators to poison bait (as with "coyote-getters", M-44's) would attract condors and increase their risk of poisoning. The hypothesis, though also true, that condors pick up visual cues from Turkey Vultures, Magpies *Pica pica*, and Ravens *Corvus corax* to locate carcasses, does not alleviate this concern. The assumption that olfaction in condors is minor is untested.

Olfaction in birds has been demonstrated in Turkey Vultures and suggested for King Vultures *Sarcoramphus papa* and condors (Stager 1964), demonstrated in Fulmars *Fulmarus glacialis* and Sooty Shearwaters *Puffinus griseus* (Hutchinson and others 1984), indicated for storm-petrels (Webb 2004), and may be more prevalent than is realized.

Salmon

There are no records of condors feeding on salmon in California (Wilbur 1973), whereas observations of salmon (n=6) and 28 of 86 condor observations from the Columbia River and its tributaries indicate their importance as food for condors in the Pacific Northwest. The year-round distribution of condors (Wilbur 1973; Sharp 2008) parallels the year-round occurrence of salmonids in northwestern tributaries and streams (Douglas 1904a, 1904b; Townsend 1848; Nelson 1978; Aguilar 2005; B Bakke, Oregon Native Fish Society, pers. comm.), "in all 13 moons" (K Smith pers. comm.), even in winter (Putnam 1928). A higher than expected number of condor observations in the fall, particularly September in this study (Sharp 2008), and a September influx of condors might be expected if salmon runs were stronger in the fall. A preliminary review of the historical strength of seasonal runs of *live* returning Columbia River salmon of 4 species indicates that this is not the case (Johnson and others 1991; Anderson 1997; Washington Department Fish and Wildlife 2008; M Newsom, Bureau Reclamation, Portland OR, pers. comm.). However, condors in the Columbia basin fed on dead, spawned-out salmon, not just live returning fish (Appendix). Because five spring, summer, and fall-returning salmon runs (of several species) spawn in the fall, carcasses are abundant at that time of year (M Newsom pers. comm.). "The Narrows [Coyote's Fishing Place] was active...all year-round. Celilo was fished only in late summer and early fall....The fisheries provided about 18 million pounds annually for the Indians of the Columbia... the non-Indian commercial fishing grew rapidly, and by 1883 the catch was nearly 43 million pounds.... In the fall of the year after spawning time the old salmon would die and millions of them would float down the river." (Aguilar 2005 pp 110, 118,120).

Marine mammals

Whales often beached on Oregon and Washington coasts, were essential to tribal identity for the Clatsop (Ruby and Brown 1981 p 113) (Appendix), and blubber was an important item for food and trade (Lewis and Clark 1990; Coues 1897). In addition to the single observation of condors feeding on "the remains of a whale" in the Columbia River estuary on November 18 1805 (Lewis and Clark 1990 vol. 6 p 66), Harris (1941) gave three instances of condors feeding on whales in coastal California. In 2006, reintroduced captive-reared condors fed on a gray whale *Eschrichtius robustus* beached at Big Sur, California (J Burnett, Ventana Wilderness Society, pers. comm.). Koford (1953 p 67) was the first to speculate that "With the decline of the large Pleistocene mammals, part of the population of condors may have shifted their foraging area to the seashore", as did Emslie (1986), Snyder and Snyder (2000), and Chamberlain and others (2005). In late spring, 2006, reintroduced condors fed on a gray whale *Eschrichtius robustus* beached at Big Sur, California (J Burnett, Ventana Wilderness Society, pers. comm.). An adult blue whale *Balaenoptera musculus* beached on the Washington coast in 2006 was buried as a public nuisance, a management policy which would need to be reviewed if condors are reintroduced to the Northwest.

Number of condors in foraging groups or at carcasses

The largest groups of condors observed in the Northwest were 9 on 3 Oct 1826 in the foothills of Cascades in the upper Willamette River valley (Douglas 1959; Nelson 1978), "several fiew" (sic) on October 30 1805 along the mid-Columbia River near its confluence with Wind River (Lewis

and Clark 1990), and 9 in the 1960s near Centralia (K Smith pers. comm.). In California the largest groups were 50 by Koford (1953), 85 in the Koford era (Snyder and Snyder 2000 p 65), larger than Koford's estimate of the total population; and there were numerous observations of two dozen or more (Howard 1938; Johnson 1945; Lofberg 1936; Koford 1953; Wilbur 1978). The importance for management of group foraging is that "The social nature of feeding in this species predisposes it to multiple mortality events from single contaminated carcasses" (Snyder and Snyder 2000 p. 261), both in the Northwest and in California.

Poison as reason for decline - hunter-killed deer and elk

It is clear that reduced Northwest salmonid populations, not destroyed until the late-1800s (Aguilar 2005), were not the probable cause of the extinction of condors in this region. The disappearance of the condor from the Pacific Northwest at the same time the condor population was declining in numbers and contracting its range in California (Sharp 2008) suggests that the same factor was operating in both populations. Snyder and Snyder (2000) suggested condors in both California and the Northwest would have been exposed to lead poisoning for the past two centuries, with drastic consequences in both places. Nineteenth century observations of condors opportunistically scavenging hunter-killed deer and elk in the Pacific Northwest (n=4) supports the hypothesis that after the arrival of European settlers armed with guns in western North America, condors' dependence on carrion, group foraging, and association with humans became life-threatening instead of life-sustaining.

In California, Howard's report (1938) of 4 condors feeding on a hunter-killed deer, and 2 weeks

later, a dead condor carcass, is suggestive of lead poisoning. Harris (1941) related observations of condors feeding on hunter-killed game. Snyder and his team first realized the significance of lead contamination as a more than occasional, systematic mortality factor in the mid-1980s, and have discussed it at length (Snyder and Snyder 2000). Radio-tracking of captive-reared birds released in Arizona and California (Mee and Hall 2007), and recent analysis of lead isotopes in condor blood samples (Church and others 2006), have strengthened the hypothesis that ingestion of lead from ammunition in carcasses of animals killed by hunters is indeed the reason for most elevated condor blood lead levels, and resulting mortality. The condor supplemental feeding program in California in the 1970s used confiscated deer carcasses, some of which contained lead shot (Jesse Grantham, Condor Recovery Coordinator, pers. comm; Noel Snyder pers. comm.). “Lead exposure, indicated by blood samples, is virtually ubiquitous among free-flying condors...an unmanaged, self-sustaining population probably cannot exist...” (Cade 2007). Poisoning incidents are still occurring. In Arizona in winter 2007, 4 breeding-age condors, including a known member of a pair, died of lead poisoning (J Grantham pers. comm.).

Exposure to lead would be no less of a problem in the Northwest than in California if condors were reintroduced to this region.

Poison as a reason for decline - predator control

A consensus of some of the most knowledgeable ornithologists in North America is that the recent decimation of the California Condor population occurred after western ranchers used poisoned carcasses to control large predators (wolves, grizzly bears, cougars) (Henshaw 1876;

Ridgway 1880; Cooper 1890; Hornaday [per Harris 1941]; Finley 1908; Emslie 1986; Glinski 1998; Snyder and Snyder 2000; Houston 2001; Ferguson-Lees and Christie 2001).

In contrast, 2 workers (Harris 1941; Wilbur 1973, 1978, 2004) questioned the significance of the effect of poisoning on condors. Harris' opinion that condor population decline was caused by something other than poisoning was based on “the general knowledge of the toxic resistance possessed by vultures.” That resistance does not exist; it is inconsistent with all the data from numerous observations and studies of a variety of American, African and Asiatic vulture species which have demonstrated vultures were indeed poisoned and killed, and even that some vulture populations have been decimated as a result. Harris' proposal that the cause of condors' decline was the "...extinction of the giant mammalian fauna of the Pleistocene...", and that "decimation of the species by poison was merely assumed to account for a seemingly sudden decrease in its numbers”, fails to account for condors surviving the Pleistocene and the Holocene only to become rare or extinct in county after county in California exactly when the west was being settled and poisons came into widespread use.

Wilbur (1978, 1983, 2004) was also skeptical about the significance of the effect of poisons on condors. "It is doubtful that poison losses figured significantly in the major condor decline of the late 19th century ... *occasional losses* since then have probably combined with mortality from other causes” (Wilbur 1978 p 22). "No condor is *known* to have died or been made ill by rodent poisoning, although strychnine and thallium sulfate are certainly toxic enough *to have caused harm on occasion*" (my emphasis) (Wilbur 2004 p. 214-15). "The second half of the nineteenth century was a period of major use of strychnine in California...it has to be assumed that some condors fell victim. The important question is how many? I think it is doubtful that poison losses

figured significantly in the condor population decline occurring before 1910 - I think there would have been at least a few first-hand reports" (Wilbur 2004 p 41).

In fact there were “first-hand reports.” Strychnine poisoning of predators since white settlement was common throughout the west in the 1800's and much of the 1900's. Two incidents of poison (strychnine) used to kill predators in the Northwest may have killed condors (this study). Numerous incidents of condor deaths coincidental with the use of strychnine, 1080, and cyanide used for predator control in California include: 1) testimony of the foreman of the Tejon ranch in the 1870s that “before this poisoning was done, both wolves and condors were plentiful in the Tejon country” (Snyder and Snyder 2000); 2) 3 incidents of probable strychnine poisoning in 1890, 1950, and 1966 (Wilbur 2004 p. 212); 3) 3 instances of condors found dead or sick in the Granite area where 1080 was used (Williams 1950; Miller and others 1965; Wilbur 2004); 4) tens of thousands of Turkey and Black Vultures killed by ranchers in Texas during the 1950s, 1080 the “preferred method of control” (Parmalee 1954); 5) tests of 1080 performed at Patuxent on captive Golden Eagles *Aquila chrysaetos*, Magpies *Pica pica*, Pacific Black Ducks *Anas superciliosa*, and Turkey Vultures, documenting a range of effects, including mortality and incapacity (Eisler 1995). Under field conditions, where food would not be furnished and protection from predators would not be provided, incapacity (sickness, lethargy, digestive failure, kidney failure, inability to forage, parental neglect, starvation, and predation) would result in mortalities; 6) the “quantitatively conspicuous” rate of predation of reintroduced condors (Mee and Snyder 2007 p 252) is consistent with sublethal effects; 7) the discovery of fluorescence-labelled cyanide in the mouth of a condor in 1983 was proof of death from poisoning. The predator control program conducted in California by Animal Damage Control (ADC) (then with U.S. Fish and Wildlife Service, now with U.S. Department of Agriculture),

was the largest poisoning program in the western United States at the time. That particular death occurred a little more than a year after a legally required “Internal Section 7 Consultation” found that the California ADC program posed "no jeopardy" to California Condors (pers. obs.). According to the in-house review following the incident Wilbur (2004 p. 213) stated, "it came as a considerable surprise ... considering all the safety features built into M-44 use in condor habitat", safety features that were obviously ineffective in this case. Snyder and Snyder (2000 p. 250) conclude that there is no safe way to use M-44s.

Wilbur himself (1978 p 15) puzzled over the sudden loss of 15 condors in the coast range: "the abrupt cessation of reports suggests that some mortality factor affected the whole group at once." Given group foraging by condors, widespread use of poisons, and susceptibility of vultures to poisoning, it seems the best explanation was a poisoning event affecting a group of foraging condors.

Instances of vulture losses implicating poisoning on other continents includes: 1) In Cape Province, South Africa in 1984, “a single strychnine-poisoned cow carcass killed 42 Cape vultures [*Gyps coprotheres*] ...ten percent of the total population in this part of Africa....half of all farmers in South Africa routinely used strychnine for predator control” (Mundy 1983). 2) “A single dead cow in Botswana was found with 79 poisoned vultures dead nearby” (ibid.). 3) “In 1979 one poisoned elephant carcass in Caprivi killed six lions and 150 Cape vultures. A few of these incidents can kill most of the vultures in an area. Because vultures collect in large numbers at a single feeding site, and come there from a considerable distance, an isolated poisoning event can have a devastating influence on vulture populations over a whole country.” (Houston 2001 p 62). 4) In Israel, “the main factors affecting vulture populations ... after 1950 were...applications

of thallium sulfate as a field mouse rodenticide...and the growing use of chlorinated hydrocarbon pesticides in agriculture. More than 600 different pesticides are approved and used in Israel currently....Some of the evidence is circumstantial. The main decline in numbers of most of the vultures occurred between 1950 and 1970, the period of major use of thallium sulfate and persistent chemicals....populations of vultures and other raptors decreased the most in agricultural areas where pesticide use was the greatest" (Mendelssohn and Leshem 1983). 5) "There were also direct losses attributable to various poisons. Immature Lappet-faced Vultures **[***Torgos tracheliotos*] were found feeding in the western Negev on thallium-poisoned field mice; they died of secondary poisoning..." (ibid.). 6) One migrant Cineraceous Vulture is known to have been affected by secondary poisoning by thallium sulfate, as were Egyptian Vultures [*Neophron percnopterus*] that fed on thallium-poisoned field mice (ibid.). 7) "Nine griffons [*Gyps fulvus*] died recently after feeding on a cow carcass poisoned by an unidentified chemical; many other affected but still alive griffons were nearby." (ibid.). 8) "Altogether, twenty-three Common Griffons were found poisoned in 1980. Two that were examined contained high levels of fluor [1080]. Several affected ones could be rehabilitated and released...." (ibid.). 9) "One Lappet-faced Vulture died after feeding on endrin-poisoned Chukar Partridges [*Alectoris chukar*]...and another was found in June 1979 dying of fluor poisoning. The latter had fed on sodium fluoracetate[1080]-poisoned rats that had, contrary to regulations, been disposed of on a garbage dump." (ibid.). 10) In France, "Strychnine baits put out for foxes have poisoned vultures, although the use of this poison has been restricted since 1981." (Terrasse 1983). 11) In India and Pakistan, 98% of the vulture population has disappeared in the last 5 years due to diclofenac poisoning (Green and others 2004, Gilbert and others 2006).

Even though circumstantial, the evidence is overwhelming that condors in North America and

vultures on three continents were poisoned. To dismiss such a mass of evidence to me was astonishing. The risk of poisoning condors is probably as high in the Pacific Northwest as in California and Arizona, where lead ammunition and poisons for predator and rodent control are both still being used, and poisonings are still occurring. One known incident was in June 2006, when 10 of 13 condors from the captive-reared population at The Pinnacles were trapped and treated after condors were poisoned by a ground squirrel killing operation near Salinas (Monterey County Herald 20 Jun 2006).

Collecting and Shooting as Cause of Decline

Wilbur (1973) suggested that the Oregon condor population may have been exterminated by collectors and shooting. Museum collecting was indeed fashionable and excessive, but in the period when most collecting occurred, 1805 to 1920, the number of specimens taken in the Northwest (n=13) (Wilbur 1973, 1978; this study) was 0.11/year, seemingly too few to explain the condors' disappearance. Tolmie's observations of flocks of condors in 1833 at 2 deserted Indian villages (Tolmie 1963) indicate that the spate of early collecting in the Northwest between 1805 and 1835 did not result in condors' disappearance from the Columbia River.

Wilbur (1978) also thought shooting and museum collecting were the main causes of the condor decline in California. However, the number of condors collected in California per year was small, only 7 by 1860 (Wilbur 1978), and by that time, condors had already disappeared from several counties and were locally extinct (Koford 1953; Wilbur 1978). However, condor population declines *were* simultaneous with the use of poisons in the environment.

The improbability of finding carcasses

To evaluate the population impact of shooting, poisoning, or any other mortality factor, it is necessary to consider the probability of finding carcasses. Snyder and Snyder (2000) pointed out that the probability of reporting condors collected for museums is obviously close to 100%. In contrast, the probability of finding any carcasses of condors that died of any natural or unnatural cause would be close to zero within "the vast area" of condor foraging range, "some 4.5 million hectares (10.8 million acres) ... much of it rugged and isolated." (Wilbur 1978 p 14). In the Northwest Gabrielson and Jewett (1970) also remarked on the unexplored, de facto wilderness character of national forests and mountainous areas of the Cascades as late as 1940. Long-distance movements of condors to and from foraging areas, the fact that no attempt at all was made to find carcasses in that "vast area", the impossibility for field workers to cover the territory almost single-handedly, the impenetrability of the vegetation and terrain, and the fact that condors were not radio-tagged until the 1980s, were tantamount to an ineffective search effort for carcasses, whether poisoned or not. Finding any condor carcass was a highly improbable event, and inversely, one carcass found represented an unknown but very large number of carcasses *not* found. Perhaps lower than 1 carcass in 1000 was found. Koford found 1 condor carcass in his several years of field work (Koford 1953 pp 139ff). The characterization of the loss of condors due to poisoning "through the years" as "occasional" (Wilbur 2004 p. 212) does not take into consideration the improbability of finding carcasses.

Avian studies in general demonstrate that the proportion of birds present that are detected by censuses or surveys is often surprisingly low. Of an estimated 675,000 seabirds killed by the

Exxon Valdez oil spill, 30,000 seabird carcasses were found during an intensive search effort of Alaskan shorelines, 8% of the estimated mortality (Ford and others 1991). After the Amoco oil spill in Brittany, 1 of 9 large gull-sized bird carcasses was found by a search team on a sandy beach during fair weather, and in Scotland 1 of 5 dead birds present on an easily-searched beach were detected (Monnat and Guermeur 1979). Of 100 small and medium-sized bird carcasses scattered over 6 acres of bare stubblefield at Patuxent Wildlife Research Center, two days later 15 searchers found 11, and most were scavenged (Williams 1997). Band recovery rates, which rely on the general public to find and report dead birds, are less than 1 in 1000 (<0.1%) for passerine species, and for conspicuous large birds such as raptors and seabirds <4% (Bird Banding Laboratory data, pers. obs.).

All released captive-reared condors have been radio-tagged. The resulting data confirm a high mortality rate that was not previously detectable. After reintroduction of radio-tagged condors in Arizona, 47% were found dead or incapacitated in the first 2 years (www.arizonaes.fws.gov); most of the mortality was due to concentrations of lead picked up by condors scavenging in groups on hunter-killed big game. Some birds found were alive but incapacitated, unable to forage. Had they not been located, captured, and treated, most would have died (Snyder and Snyder 2000). The logical inference from the radio-tagging data is that similar levels of mortality and incapacity had been affecting condors for 200 years (Snyder and Snyder 2000), with no way to detect them. Despite telemetry, there are still “surprisingly large numbers of condors dying without recovery” (Mee and Snyder 2007 p 272); this is to be expected given the extent and impenetrability of condor foraging range in both California and Arizona.

Proportion of poisoned carcasses needed to exert a population effect on condors

Condors often ingest lead by finding game that dies as a result of crippling loss. Measured rates of crippling loss in controlled white-tailed deer *O. virginianus* hunts was 10-15% in Michigan (Van Etten and others 1965) and 33% in Illinois (350 of 1073 deer harvested) (Roseberry and others 1969). For population and harvest modeling purposes in the open arid country of eastern Oregon, crippling loss of black-tailed deer *O. hemionus* is estimated at 10% (R Morgan, Oregon Dept. Fish and Wildlife [ODFW], pers. comm.), and is probably higher in more heavily forested western Oregon. An idea of the number of contaminated carcasses available to condors in Oregon can be obtained from recent estimates of the deer population (550,000) and harvest (50,000), with crippling losses on top of that (P Test, ODFW, pers. comm.). An impression of the extent of crippling loss in the early 1800s is given by Lewis and Clark for 13 June 1806 (1990 vol. 8 p 22-23): "About noon 7 of our hunters returned with 8 deer; *they had wounded several others and a bear but they did not get them*" (my emphasis).

Green and others (2004) observed that "rates of population decline [of White-backed Vultures *Gyps bengalensis*] could be caused by contamination with a lethal level of diclofenac in a small proportion (between 1:130 and 1:760) of ungulate carcasses available to vultures", and Gilbert and others (2006) report only 1-3% of the carcasses being contaminated. Whether 10% or 35% or something in between, observed crippling losses and therefore the rate of lead contamination of deer and elk carcasses available to scavengers in the Northwest would seem at least equal to and probably greater than the rate of diclofenac contamination of carcasses in Asia, and therefore be sufficient to cause regular, ongoing, cumulative mortalities in groups of scavenging condors. Lead contamination levels over two centuries of European settlement thus would easily explain

the relentless disappearance of condors from successive parts of their shrinking range, and their coincidental ecological extinction in the wild by 1987 in both California and the Pacific Northwest. Poisoning would present a similar frustration of public hopes and scientific expectations for re-establishment if condors were reintroduced to the Pacific Northwest.

Pioneering of condors

The resident, probably breeding population of condors in the Pacific Northwest, with its greatest abundance along the Columbia River and its tributaries (Sharp 2008) was presumably founded by pioneering foraging condors that discovered and occupied a foraging niche in suitable unoccupied habitat. Likewise, a possibly semi-transient population east of the Rocky Mountains may have derived from the Columbia River population. Radio-tagged captive-reared condors released at Big Sur have been observed pairing with condors from southern California and breeding there, and condors released in Arizona are foraging on their own in Utah, despite attempts to keep them on artificial food subsidy (Jesse Grantham pers comm). The re-occurrence of condors in Arizona in the late 1800s (Rea and Snyder 1998) after an absence since the Pleistocene (southwest Indian tribes were unfamiliar with condors [Sharp 2008]) was probably also a result of foraging condors discovering and exploiting a new food supply, namely cattle of European pioneers (Emslie 1986). Long-distance pioneering is probably a pre-adapted capability of foraging California Condors.

Management implications of the Northwest data

A full discussion of condor management in the Northwest is beyond the scope of this paper. Whatever specific management strategies are adopted, it is advisable they be based on relevant, available data. In the Northwest, those data include the historical distribution of condors in northwestern North America (Sharp 2008), and this study of their foraging niche. In addition, the Northwest data supplement, and are supplemented by, data on condors and other vulture species in California and elsewhere, all of which need to be the basis of management decisions if reintroduction of condors to the Northwest is to be successful.

Briefly, management implications of the historical data would include consideration of geographical and temporal distribution in choosing and managing re-introduction sites, and perhaps more importantly, management of the foraging niche. It is "axiomatic" (Snyder and Snyder 2000) and also consistent with available information from the Northwest, that state and federal agencies must address and eliminate beforehand the major factors that were the cause of deaths of condors in the past, namely toxic chemicals in the foraging environment.

Available data also suggest that salmon, alive and/or dead, were an important part of the condor diet year-round on the Columbia River and its tributaries; therefore, restoration of condors into the Northwest could depend on management and recovery of salmon populations. "Nearly every population of naturally producing anadromous salmonids in the Columbia River Basin is now listed, or is a candidate for listing, under the [Endangered Species Act]" (US Fish and Wildlife Service 2005 p 1-4), and some runs are extinct, for example the dog salmon *Oncorhynchus keta* run on the Wind River (Aguilar 2005), where Lewis and Clark first encountered condors in October 1805. The Columbia Basin is referred to by managers as a "hydrosystem", and no longer functions as a salmon-producing ecosystem (Harden 1996). Its management is an ongoing

natural resource management controversy in the Pacific Northwest.

Condor management in the Northwest might also include strategies that encourage pioneering, which for various reasons have not been included in the condor recovery program to date (U.S. Fish and Wildlife Service 1996; Walters and others 2008).

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LITERATURE CITED

AGUILAR GW SR. 2005. When the River Ran Wild: Indian Traditions on the mid-Columbia and the Warm Springs Reservation. Oregon Historical Society Press, Portland, USA. 252 p.

AUDUBON JJ. 1839. Ornithological Biography, or an Account of the Habits of the Birds of the United States. Vol. 5. Adam and Charles Black, Edinburgh, UK.

BOYD R. 1996. People of the Dalles: the Indians of the Wascopam Mission. University Nebraska Press NE. 396 p.

BOYD R. 1999. The Coming of the Spirit of Pestilence: Introduced Infectious Diseases and Population Decline among Northwest Coast Indians, 1774-1874. University of Washington Press, Seattle, WA. 403 p.

BUCKLEY NJ. 1999. Black Vulture (*Coragyps atratus*). In: POOLE A, GILL F, editors. Birds of North America Number 411. The Birds of North America Inc., Philadelphia, PA. 23 p.

BURROUGHS RD. 1961. The Natural History of the Lewis and Clark Expedition. Michigan State University Press. East Lansing, MI. 340 p.

CADE TJ. 2007. Exposure of California Condors to lead from spent ammunition. Journal of Wildlife Management 71:2125-2133.

CHAMBERLAIN CP, WALDBAUER JR, FOX-DOBBS K, NEWSOME SD, KOCH PL,

SMITH DR, CHURCH ME, CHAMBERLAIN SD, SORENSEN KJ, RISEBROUGH R. 2005. Pleistocene to recent dietary shifts in California Condors. Publications of Natural Academy of Science 102:16707-16711.

CHURCH ME, GWIAZDA R, RISEBROUGH RW, SORENSON K, CHAMBERLAIN CP, FARRY S, HEINRICH W, RIDEOUT BA, SMITH DR. 2006. Ammunition is the principal source of lead accumulated by California Condors re-introduced to the wild. Environmental Science Technology 40:6143- 6150.

COLLINS PW, SNYDER NFR, EMSLIE SD. 2000. Faunal remains in California Condor nest caves. Condor 102:222-227.

COOPER JG. 1890. A doomed bird. Zoe 1:248-49.

COOPER JG, SUCKLEY C. 1860. The natural history of Washington Territory and Oregon, being those parts of the final reports of the survey of the Northern Pacific Railroad route, relating to the natural history of the regions explored, with full catalogues and descriptions of the plants and animals collected from 1853 to 1860, with the cooperation of Messrs Baird, Girard, Stimpson, Geo. Gibbs, Kennicott, Torrey, Gray, Cassin, and Lawrence. Bailliere Brothers, London, UK. 399 p.COUES E, editor. 1897. New light on the early history of the greater Northwest. The manuscript journals of Alexander Henry, Fur Trader of the Northwest Company, and of David Thompson, Official Geographer and Explorer of the same Company, 1799-1814. V. II. The Saskatchewan and Columbia Rivers. Ross and Haines Inc., Minneapolis USA. 1027 p.

DEBLIEU J. 1991. Meant to be Wild: The Struggle to Save Endangered Species Through Captive Breeding. Fulcrum Publishing, Golden, CO.

DEMERS M, BLANCHET FN, BOLDUC JBZ, LANGLOIS A. 1956. Notices and Voyages of the Famed Quebec Mission to the Pacific Northwest.

LANDERHOLM C, translator, Oregon Historical Society, Portland, USA. 243 p.

DE SMET PJ. 1978. Oregon Missions and Travels over the Rocky Mountains in 1845-46. Reprint of 1847 edition. Ye Galleon Press, Fairfield, WA. 426 p.

DOUGLAS D. 1829. Observations on the Vultur Californianus of Shaw. Zoological Journal 4:328-330.

DOUGLAS D. 1904a. Sketch of a journey to the northwestern parts of the continent of North America during the years 1824-25-26-27. Oregon Historical Quarterly 5:230-271.

DOUGLAS D. 1904b. Sketch of a journey to the northwestern parts of the continent of North America during the years 1824-'25-'26-'27. II. Oregon Historical Quarterly 5:325-369.

DOUGLAS D. 1959. Journal kept by David Douglas during his travels in North America, 1823-1827. Antiquarian Press, New York, USA. 364 p.

EISLER R. 1995. Sodium monofluoroacetate (1080) hazards to fish, wildlife, and invertebrates: A Synoptic Review. Contaminant Hazard Review No. 30. Patuxent Environmental Science Center, U.S. Geological Survey, Laurel MD. (CD).

EMSLIE SD. 1986. Canyon Echoes of the Condor. Natural History April 1986:10-14.

EWERS JC. 1949. The last bison drives of the Blackfoot Indians. Journal Washington Academy Science 39:355-360.

FERGUSON-LEES J, CHRISTIE DA. 2001. Raptors of the World. Houghton-Mifflin Co., NY. 320 p.

FERMOR PL. 1992. Three Letters from the Andes. Penguin Books, London, UK. 112 p.

FINLEY WL. 1908. Life History of the California Condor. Part II. Condor 10:5-10.

FLEMING JH. 1924. The California condor in Washington: another version of an old record. Condor 26:111-112.

FORD RG, BONNELL ML, VAROUJEAN DH, PAGE GW, SHARP BE, HEINEMANN D, CASEY JL. 1996. Total Direct Mortality of Seabirds from the *Exxon Valdez* Oil Spill. In: RICE SD, SPIES RB, WOLFE DA, WRIGHT BA. Proceedings of the *Exxon Valdez* Symposium. American Fisheries Society Symposium 18: 684-711.

GABRIELSON IN, JEWETT S. 1970. Birds of the Pacific Northwest. Dover Publications Inc., New York, USA. 650 p.

GIBBS G. 1863. A Dictionary of the Chinook Jargon, a Trade Language of Oregon. Smithsonian Institution, Washington D.C. 43 p.

GILBERT MRT, WATSON MZ, VIRANI JL, OAKS S, AHMED MJI, CHAUDHRY M, ARSHAD S, MAHMOUD A, ALI A, KAHN AA. 2006. Rapid population declines and mortality clusters in three Oriental white-backed vulture Gyps bengalensis colonies in Pakistan due to diclofenac poisoning. Oryx 40:388-399.

GLINSKI RL. 1998. Conservation of Arizona raptors. In: GLINSKI RL, editor. Raptors of

Arizona, Arizona Press, Tucson AZ. p 3-9.

GREEN RE, NEWTON I, SCHULZ S, CUNNINGHAM AA, GILBERT M, PAIN DJ, PRAKESH V. 2004. Diclofenac poisoning as a cause of vulture population declines across the Indian subcontinent. Journal Applied Ecology 41:793-800.

HARDEN B. 1996. A River Lost: Life and Death of the Columbia. W.W. Norton&Co. New York and London. 271 p.

HARRIS H. 1941. The annals of Gymnogyps to 1900. Condor 43:3-55.

HENSHAW HW. 1876. Report on the ornithology of the portions of California visited during the field season of 1875. In: WHEELER GM. Annual report upon the geographical survey west of the 100th Meridian in California, Nevada, Utah, Utha, Colorado, Wyoming, New Mexico, Arizona and Montana. U.S. Govt. Printing Office, Washington D.C. p 224-278.

HOUSTON D. 2001. Condors and Vultures. Voyageur Press, Stillwater MN. 72 p.

HOWARD H. 1938. Cooper Ornithological Society Meeting Notes. Condor 40:132.

HUTCHINSON LV, WENZEL BN, STAGER KE, TEDFORD BL. 1984. Further evidence for olfactory foraging by Sooty Shearwaters and Northern Fulmars. In: NETTLESHIP DN, SANGER GA, SPRINGER PF, editors. Marine birds: their feeding ecology and commerical fisheries relationships.

Proceedings Pacific Seabird Group Symposium, 6-8 Jan 1982, Seattle WA. p 72-77.

JOHNSON HT. 1945. California condors in San Luis Obispo County, California. Condor 47:38.

KIRK DA, MOSSMAN MJ. 1998. Turkey Vulture (*Cathartes aura*). In: POOLE A, GILL F, editors. Birds of North America Number 339. The Birds of North America Inc., Philadelphia, PA. 32 p.

KOFORD CB. 1953. The California Condor. Dover Publications, New York, USA. 154 p.

LEWIS M, CLARK J. 1990. The Definitive Journals of the Lewis and Clark Expedition. MOULTON GE, editor. University Nebraska Press, Lincoln NE. Vols. 2-8.

LONG F. 1909. Dictionary of the Chinook Jargon. Lowman and Hanford Company, Seattle, WA. 41 p.

MCLOUGHLIN J. 1948. Letters of Dr. John McLoughlin, Written at Fort Vancouver 1829-1832. BROWN B, editor. Barker, Binford, and Mort. Oregon Historical Society, Portland OR. 376 p.

MEE A, HALL LS. 2007. California Condors in the 21st Century. Nuttall Ornithological Club and American Ornithologists' Union. Buteo Books. 279 p.

MEE A, SNYDER NFR. 2007. Conservation Problems and Solutions. In: MEE A, HALL LS. California Condors in the 21st Century. Nuttall Ornithological Club and American Ornithologists' Union. Buteo Books. p 243-279.

MENDELSSOHN H, LESHEM Y. 1983. The status and conservation of vultures in Israel. In: WILBUR SR, JACKSON JR, editors. Vulture biology and Management. University California Press, Berkeley and Los Angeles CA. p 86-98.

MEYBURG B, MEYBURG C. 1983. Vultures in Mongolia. In: WILBUR SR, JACKSON JR, editors. Vulture biology and Management. University California Press, Berkeley and Los Angeles CA. p 99-106.

MILLER AH, MCMILLAN I, MCMILLAN E. 1965. The current status and welfare of the California condor. National Audubon Society Research Report 6:1-61.

MILLER LH. 1942. Succession in the Cathartine Dynasty. Condor 44:212-13.

MILLER LH. 1957. Bird remains from an Oregon Indian midden. Condor 59:59-63.

MONNAT JY, GUERMEUR Y. 1979. L'Amoco Cadiz et les Oiseaux. Societe pour L'Etude et la Protection de la Nature en Bretagne. Ministere de L'Environnement et du Cadre de Vie. Brest, France. 239 p.

MUNDY PJ. 1983. The conservation of the Cape Griffon Vulture of Southern Africa. In: Wilbur SR, Jackson JR, editors. Vulture biology and Management. University California Press, Berkeley and Los Angeles CA. p 57-74.

NELSON VJ. 1978. David Douglas on the Columbia. Smith, Smith, and Smith Pub. Co., Lake Oswego OR. 18 p.

NIELSEN J. 2006. Condor, to the Brink and Back: the Life and Times of One Giant Bird. HarperCollins, N.Y., USA. 257 p.

OGDEN PS. 1933. Traits of American Indian Life and Character, by a Fur Trader. Grabhorn Press, San Francisco, USA. 107 p.

ORDWAY J. 1916. The Journals of Captain Meriwether Lewis and Sergeant John Ordway, kept on the Expedition of Western Exploration, 1803-1806.

QUAIFE MM, editor. State Historical Society, Madison, USA. 444 p.

PARMALEE PW. 1954. The vultures, their movements, economic status, and control in Texas. Auk 71:443-453.

PEALE TR. 1848. U. S. Exploring Expedition During the Years 1838, 1839, 1840, 1841, 1842 under the Command of Charles Wilkes, U. S. N. Vol. 8: Mammalia and Ornithology. C. Sherman, Philadelphia PA.

PUTNAM R. 1928. The letters of Roselle Putnam. Oregon Historical Quarterly 29(3):242-264.

RIDGWAY R. 1880. Notes on the American vultures (Sarcorhamphidae), with special reference to their generic nomenclature. Bulletin Nuttall Ornithological Club 5:77-84.

ROSEBERRY JL, CANTRY DC,. KLIMSTRA WD, MERHOFF LA JR 1969. A controlled deer hunt on Crab Orchard National Wildlife Refuge. Journal of Wildlife Management 33:791-795.

RUBY RH, BROWN JA. 1981. Indians of the Pacific Northwest: a History. University of Oklahoma Press, Norman OK. 294 p.

SCHAEFFER CE. 1951. Was the California condor known to the Blackfoot Indians? Journal Washington Academy Science 41:181-191.

SCHUEZ E, KOENIG C. 1983. Old world vultures and man. In: WILBUR SR, JACKSON JR,

editors. Vulture biology and Management. University California Press, Berkeley and Los Angeles CA. p 461-469.

SHARP BE. 2008. California Condors in Northwestern North America. www.ecologicalperspectives.com.

SNYDER N, SNYDER H. 2000. The California Condor: A Saga of Natural History and Conservation. Academic Press, London, UK. 410p.

SNYDER NFR, REA AM. 1998. California Condor *Gymnogyps californianus*. In: GLINSKI RL, editor. The Raptors of Arizona, University of Arizona Press, Tucson, USA. p 32-36.

SNYDER NFR, SCHMITT NJ. 2002. California Condor (*Gymnogyps californianus*). In: POOLE A, GILL F, editors. Birds of North America Number 610. The Birds of North America Inc., Philadelphia, PA. 35 p.

STAGER KE. 1964. The role of olfaction in food location by the Turkey Vulture (Cathartes aura). Los Angeles County Museum Contributions in Science No. 81.

TERRASSE M. 1983. The status of vultures in France. In: WILBUR SR, JACKSON JR, editors. Vulture biology and Management. University California Press, Berkeley and Los Angeles CA. p 81-85.

THOMAS EH. 1935. Chinook: A History and Dictionary of the Northwest Coast Trade Jargon: The Centuries-old Trade Language of the Indians of the Pacific. Metropolitan Press, Portland, OR. 179 p.

TOLMIE WF. 1963. William Frasier Tolmie, Physician and Fur Trader. Mitchell Press Ltd., B.C., Canada. 413 p.

TOWNSEND JK. 1848. Popular monograph on the accipitrine birds of N.A. - No. II. Literary Record and Journal of the Linnaean Association of Pennsylvania College 4:265-272.

TURNER H. 1976. Ethnozoology of the Snoqualmie. 2nd edition revised. Self-published. Available from Multnomah County Library, Portland, OR. 105 p.

U.S. FISH AND WILDLIFE SERVICE. 2005. Caspian Tern management to reduce predation of juvenile salmonids in the Columbia River estuary: Final Environmental Impact Statement. Portland OR. 303 p.

U.S. FISH AND WILDLIFE SERVICE. 1996. Recovery Plan for the California Condor. Portland, Oregon. 62 p.

VAN ETTEN RC, SWITZENBERG DF, EBERHARDT L. 1965. Controlled deer hunting in a square-mile enclosure. Journal of Wildlife Management 29:59- 73.

WALTERS JR, DERRICKSON SR, FRY DM, HAIG SM, MARZLUFF JM, WUNDERLIE JM Jr. 2008. Status of the California Condor and Efforts to Achieve its Recovery. AOU Committee on Conservation and Audubon California, California Condor Blue Ribbon Panel. Unpublished Report, 55 p.

WEBB S. 2004. Looking for Seabirds: Journal from an Alaskan Voyage. Houghton Mifflin Co., Boston MA. 48 p.

WILBUR SR. 1973. The California Condor in the Pacific Northwest. Auk 90:196-197.

WILBUR SR. 1978. The California Condor, 1966-76: a look at its past and future. North American Fauna 72. 136 p.

WILBUR SR. 1983. The status of vultures in the western hemisphere. In: WILBUR SR, JACKSON JR, editors. Vulture biology and Management. University California Press, Berkeley and Los Angeles CA. p 113-123.

WILBUR SR. 2004. Condor Tales: What I learned in twelve years with the big birds. Symbios, Gresham OR. 400 p.

WILCOX TE. 1918. Occurrence of the California Vulture in Idaho. Journal Washington Academy of Science 8:25.

WILLIAMS T. 1997. Silent Scourge. Audubon Magazine 99(1):28-35. GASS P. 1904. Gass's Journal of the Lewis and Clark expedition. A.C. McClurg and Company, Chicago, USA. 298 p.

WILLIAMS W. 1950. [Letter regarding condors in Kern County, California.] News from the Bird-banders 25:50.

www.arizonaes.fws.gov/Documents/Documentsbyspecies/CaliforniaCondor/!10jReviewReport.Final2.pdf (accessed 2006).

www.dfg.ca.gov/hcpb/species/t_espp/condor (accessed 2006).

TABLE 1. Observations of food and foraging of condors in northwestern North America.

Species	Number of Observations	Habitat
Bison	3	Plains
Salmonids	6	Shoreline
Other fish species	1	Shoreline, saltwater
Marine mammals	2	Shoreline
Winter-killed elk	1	Forested upland
Hunter-killed deer and elk	4	Forested upland, riparian
Domestic animals	3	Forested upland, grassland
Domestic animal carcasses poisoned	2	Forested upland
Wild cranberries (kinnick-kinnick?)	1	Forested upland
Humans *Homo sapiens*	2	Shoreline, riparian

APPENDIX A. Details and sources of foraging records summarized in Table 1, by category of food item**.**

Bison: 1) Remains of bison killed by the Blackfeet and their neighbors, pre-contact Montana, 1700s to mid-1800s: “the abandonment by hunters of bison bones and offals, which in fall supplied tallow and meat for the manufacture of pemmican, afforded a source of diet for the condor and other carnivorous creatures." (Schaeffer 1951). 2) Piegan oral history: *omaxsipitau* ("big eagle") appeared infrequently in summer, attracted by remains of bison slain by the Indians on the plains (ibid.). 3) Sanderville, a tribal informant, stated condors were attracted by bison carcasses (ibid.).

Salmonids: 1) The Snoqualmie name for condor was *hed-e-lipsh*, “the one who breaks down the weirs” (salmon traps made of willows) (Turner 1976 p 52). 2) At Fort McLoughlin, near present-day Bella Bella, British Columbia, Tolmie (1963, p. 293) wrote, "Monday, November 24: After breakfast went to the lake, coasted it in the canoe throught (sic)....What I supposed a large species of vulture at the north end, along with some white headed eagles attracted probably by dead salmon." 3) Townsend (1848) collected a condor at Willamette Falls at present day Oregon City in 1835: "In a journey of exploration which I made to the Willamet, in the month of April, when the river was crowded with Salmon, making their way up against the stream, urged by an abortive (sic) instinct to pass the barriers of the thirty feet fall, I observed dozens of Turkey Vultures constantly sailing over the boiling surges, with their bare heads curved downwards as if in search of prey. As I gazed upon them, interested in their graceful and easy motions, I heard a loud rustling sound over my head, which induced me to look upward; and there, to my inexpressible joy, soared the great Californian, seemingly intent upon watching the motions of

his puny relatives below. Suddenly, while I watched, I saw him wheel, and down like an arrow he plunged, alighting upon an unfortunate Salmon which had just been cast, exhausted with his attempts to leap the falls, on the shore within a short distance. At that moment I fired, and the poor Vulture fell wounded." The specimen is in the US National Museum #78005, mislabeled "Columbia River" (C Angle, curator, pers. comm.). 4) Townsend wrote to JJ Audubon (Audubon 1839) of condors "strutting over the ground with great dignity; but this dignity is occasionally lost sight of, especially when two are striving to reach a dead fish, which has just been cast on the shore." No date or location, but details of the description is indicative of an observation, not hearsay. 5) Townsend also observed (Audubon 1839) that "during the spring, I constantly saw the Vulture at all points where the Salmon was cast upon the shores, their extreme shyness uniformly prevented an approach to within gun-shot"; "Their food while on the Columbia is fish almost exclusively, as the food is always found in great abundance near the falls and rapids"; and "It is also met with near the Indian villages, being attracted to the offal of the fish thrown around their habitations." 6) Canoe River, British Columbia, about 4 Sep 1845, De Smet (1978 p 130-31): "On arriving at the two lakes, I saw them covered with swarms of aquatic birds—coots, ducks, water-fowl, cormorants, bustards, cranes, and swans; whilst beneath the tranquil water lay shoals of salmon in a state of exhaustion....I saw them pass in great numbers, cut and mutilated, after their long watery pilgrimage among the rapids...In the absence of man, the grey and black bear, the wolf, the eagle, and vulture assemble in crowds, at this season of the year. They fish their prey on the banks of the river, and at the entrance of the lakes; --claws, teeth, and bills serving them instead of hooks and darts." Turkey Vultures do not occur in interior British Columbia at this latitude, north of 52 N, or at Canoe River specifically (Sharp 2008). 7) It was generally accepted in the 1800s that "The California vulture visits the Columbia River in fall,

when its shores are lined with great numbers of dead salmon"(Cooper and Suckley 1860); and "Cannot be considered a common bird in Oregon; we first saw them on the plains of the Willamette River...much more numerous in California, from the fact that the carcasses of large mammals are more abundant, which they certainly prefer to the dead fish on which they are obliged to feed in Oregon and all the countries north of the Spanish settlements..." (Peale 1848). Neither Peale nor Cooper personally observed condors feeding on salmon; therefore these 2 accounts are not included in Table 1.

Salt-water fish species: Lewis and Clark (1990 vol 6 p 320) alluding to a condor wounded and collected in the Columbia River estuary, November 1805: "Seen it feeding on the remains of a whale *and other fish* which have been thrown up by the waves on the Seacoast. These I believe constitute their principal food, but I have no doubt that they also feed on flesh" (my emphasis). In winter 1813-14 A Henry remarked on the surprising number of gulls and other birds that feed on marine fish washed up on shore of the Columbia River estuary (Coues 1897).

Marine mammals: 1) The Nuu-cha-nulth, a nation of 13 native tribes on outer west coast of Vancouver Island, viewed the condor as sole "enemy" and eater of killer whales (Matthew Williams, tribal elder and author, pers. comm. 2005). 2) Lewis and Clark (op. cit. vol. 6 p 66) stated "we have seen it feeding on the remains of the whale and other fish which have been thrown up by the waves on the sea coast... but I have no doubt that they also feed on flesh." A Henry made note of "blubber of a whale" cast upon shores near mouth of Columbia on 16 Nov 1813, and again on 14 Apr 1814 (Coues op. cit. pp 750, 889). Natives use of stranded whales for food and traded blubber with Europeans (Lewis and Clark, op. cit..) is reflected in the USA-Clatsop treaty negotiated in 1850 (not ratified by Congress), which "guaranteed" the Clatsops

use of stranded whales on the Oregon coast (Ruby and Brown 1981 p 113).

Winter-killed elk: Early summer,1950s, eastern slopes of Mt Jefferson, observation at close range of condors feeding on elk in melting snowbanks (Ken Smith, Wasco tribe, pers. comm.).

Hunter-killed deer and elk: 1) In the early 1800s, at Gifford-Pinchot N.F., Ellen Saluskin's grandfather killed a condor attracted by an elk he had killed; he carried a condor tail-feather as talisman the rest of his life (Cheryl Mack, Forest Service archeologist, pers. comm.; Mary Schlick pers. comm.). 2) At Deer Island, 28 March 1806, "The men who had been Sent after the deer returned with four only, the other 4 having been eaten entirely by the Voulturs (sic) except the Skin" (Lewis and Clark 1990 vol 7 p25). "J. Fields even reported to Lewis 'that the Vultures had draged (sic) a large buck which he had killed about 30 yards, had skined (sic) it and broken the back bone'" (Ordway 1916 p 333). 3) On 13 June 1806, while camped near Weippe, Idaho, according to Ordway (1916 p 366): "All the meat except Labuches was brought in & that the ravens and buzzards eat while he was hunting a little more"; of this incident Lewis and Clark wrote (1990 vol. 8 p 22-23), "About noon 7 of our hunters returned with 8 deer; they had wounded several others and a bear but they did not get them. In the evening Labuish and Cruzatte returned and reported that the buzzards had eaten up a deer which they had killed butchered and hung up this morning." Burroughs (1961 p 203-04) stated that this observation related to Turkey Vultures, but gave no reason; the observation fits the foraging profile of condors (record of appropriating hunter-killed game) (Lewis and Clark 1990; Coues 1897 p 817; Snyder and Schmitt 2002) and not Turkey Vultures (inability to feed on non-decomposed carrion, no record of appropriating big game) (Kirk and Mossman 1998). Also, Turkey Vultures not in this part of central Idaho (ibid.). 4) A Henry, fur trader at Fort George (Astoria), journal

entry for 25 Jan 1814, near the Pudding River, tributary to the Willamette River: "I sent for the eight deer killed yesterday. The man brought in seven of them, one having been devoured by the vultures. These birds are uncommonly large and very troublesome to my hunters, by destroying the meat, which, though well covered with pine branches, they contrive to uncover and devour." (Coues 1897 p 817). Turkey Vultures are not present in this area in winter (Kirk and Mossman 1998; pers. obs. 1974-2008; H Nehls,Oregon Rare Bird Alert, pers. comm.), and also were not in 1805-6 (Lewis and Clark 1990). 5) Townsend (1848) wrote, "I am told [by Indians?] of this Vulture...that it frequently pursues sick or wounded deer and other animals, until they fall..."; this condor observation is second-hand and not included in Table 1.

Homo sapiens: (1) "Intermittent fever" (malaria), "the single most important epidemiological event in the recorded history of ...Oregon" (Boyd 1999 p 84) arrived on the Columbia River in summer 1830 and lasted through November that year; it also recurred in several subsequent years. By mid-October it had "carried off three fourths of the Indian population in our vicinity" [Fort Vancouver] (McLoughlin 1948 letter number 134). The fur-trader PS Ogden (Ogden 1933 p 69), who was bed-ridden himself from malaria in mid-October, visited two villages [330 inhabitants per Boyd 1999] downriver after convalescing and documented the "utter destruction of every human inhabitant ...why linger those foul birds around the spot, gorged, and scarcely noticing my presence? ...Let these unburied carcasses resolve the question." The "foul birds" are independently identified as condors in Wasco oral history: "During the worst years, some people could no longer bury or take care of their dead. The victims of these diseases fattened the huge Thunderbirds" (Aguilar 2005 p 12). Three years later, in May 1833, Tolmie (1963 p 185) observed large vultures (condors) at 2 abandoned Indian villages on the Cowlitz and Kalama Rivers (tributaries to the Columbia), not far from the location Ogden referred to: "scared some

large vultures & crows from their feast." Tolmie had also seen "small vultures" that May. 2) H Perkins, a missionary stationed at The Dalles 1838 to 1844, recorded that Wasco slaves were "thrown to the dogs! The wolves sometimes...share the carcasse (sic) with them. Sometimes, however, it is but just to say, a delicacy of feeling, causes the corpse to be dragged to the river and thrown in, to become food at length for the greedy vultures." (Boyd 1996 p 279). "Nearly all the Wascos and some Sahaptans had slaves, and it is safe to assume that about 30% (a conservative guess) of the population of the Warm Springs were slaves" (Aguilar 2005 p 169). Slaves owned by this and many other northwest tribes (Chinook, Nuu-cha-nulth) had no claim to a "decent" burial. If deaths occurred in winter, the "lean period" ("Late winter/early spring...was a particularly bad time, mortality-wise" for northwest tribes [Boyd 1999 p 285]), the vultures referred to would have been condors, as Turkey Vultures are absent from the Columbia River in winter (see above).

Two observations that involve human carcasses and "vultures", possibly condors, are not included in Table 1. The artist P Kane wrote (1971 p 36), "one morning...I was out sketching on Vancouver's Island [British Columbia]. I saw upon the rocks the dead body of a young woman whom I had seen a few days previously walking about in perfect health, thrown out to the vultures and the crows." And in Oregon, the missionary De Smet wrote in July 1846 (1978 pp 232, 235-6). , "the Indians deposit their dead on scaffold, or in little huts made of pieces of split cedar frequently covered with mats and boards; great care is taken to hinder birds of prey, or the rapacious wolves...from breaking in upon the abode of the dead....at the great dalles...all that the eye can see, or the nose smell, is fish, and nothing but fish....At the Dalles you enter a barren region... In the absence of the savages, the tombs of the dead are sometimes pillaged by civilized *Christian* travellers [italics not mine], taking away the very boards that cover the dead bodies,

and thus leave them the prey of vultures and crows....In the immediate neighborhood of a camp the air is infected with the scent of salmon in a state of putrefaction...” Townsend's observation of condors attracted to fish offal at native villages was noted above (Audubon 1839); therefore De Smet's observation of vultures at The Dalles possibly referred to condors.

Domestic animals: 1) condors observed feeding on winter-killed horses at Fort Vancouver by George Barnston in Feb 1827 (Fleming 1924); 2) , Townsend “saw 2 condors feeding on a pig” at Fort Vancouver (Audubon 1839); 3) Near Boise, Idaho, “In the fall of 1879 I came upon two which were feeding on the carcass of a sheep. They hissed at me and ran along the ground for some distance before they were able to rise in flight. They were much larger than turkey buzzards, which which I was quite familiar, and I was very close to them so that I could not be mistaken in their identity” (Wilcox 1918).

Domestic animal carcasses laced with poison: 1) In 1851-2, upper Umpqua Valley "there has been a great many of them [wolves] killed this winter, in this neighborhood with strycknine (sic), Charles put out upwards of 30 doses of it. and I suppose every one killed a wolf... we have seen two that died near the house... the largest wild bird in the country is the vulture which is only an overgrown buzzard ... I saw one measured which I think was between ten and eleven feet from the point of one wing to the point of the other" (Putnam 1928). Wilbur (1978) had classified this specimen as "shot", but later retracted it (pers. comm. 2006). 2) In the vicinity of Boise, Idaho “The cattle-men said that the California vulture or buzzard was not uncommon there before they began to poison carcasses to kill wolves“ (Wilcox 1918).

“Wild cranberries”: Mt. Hood, Oregon, mid-1900s, condors feeding on the ground on “wild cranberries” (*Vaccinium oxycoccos*?) in high meadows late summer (K Smith, pers. comm.).