INVASIVE SPECIES RISK ASSESSMENT FOR SNAPPING TURTLES IN THE STATE OF OREGON:

INVASIVE SPECIES IDENTITY:

Scientific Name: *Chelydra serpentina serpentina* (Linnaeus, 1758)
Phylum: Chordata
Class: Reptilia
Family: Chelydridae
Common Name: Snapping Turtle
Synonyms and Other Names: common snapping turtle, snapper, tortuga lagarto; local – mud turtle

RISK RATING SUMMARY:

Overall Relative Risk Rating: MODERATE, HIGH, OR VERY HIGH
Overall Numerical Score: 3, 6 or 9
Uncertainty: The environmental impact potential of the snapping turtle (Criterion 4) in Oregon is unknown at this time. Almost all existing data is derived from snapping turtles within their native range. Snapping turtles have a wide distribution within their native range and tolerate a variety of climates. There is little supporting data on snapping turtles within their native range that indicates impact of snapping turtles on native species. Based on their ability to adapt to various environments, their omnivorous diet, their large size and lack of natural predators, and long life span with high reproductive potential, snapping turtles could easily establish reproductive populations throughout the Pacific Northwest, including Oregon. One breeding population in Oregon is known and others are suspected. Snapping turtles are known to occur in the same habitats as several special status fish and wildlife species of conservation concern (e.g., red-legged frog, western painted turtle, western pond turtle, various salmonids, and other fish). Snapping turtles could compete for food and habitat resources and cause direct mortality through predation. Other possible negative impacts and risk to Oregon's native fish and wildlife, particularly native turtle species, is the introduction of disease by snapping turtles released from the pet store trade (Bury and Luckenbach, 1976; Beebee and Griffiths, 2000).

INVASIVE SPECIES BACKGROUND:

<u>Important Note</u>: *Unless otherwise indicated, the information in the following sections is based on snapping turtles within their native range as indicated by the cited literature. See "*Nonindigenous Occurrences and Known Information for Snapping Turtles in Oregon*" section for below for information on snapping turtles in Oregon and potential implications of their presence within Oregon.*

Introduction

The snapping turtle derives its common English name from its violent anti-predator behavior which involves snapping at an adversary while quickly lunging forward and extending its neck, potentially delivering a painful, damaging wound (Ernst et al., 1994; Oldfield and Moriarty, 1994; Hammerson, 1999). This vigorous defense is exhibited out of water and does not seem to be used while submerged (Vogt, 1981). These turtles also are capable of aggression toward con-specifics and Klemens (1993) documented two males locked in combat. The snapping turtle is commonly harvested for commercial exploitation, especially for food (Christiansen and Bailey, 1988; Pough et al., 2001).

Physical Description

The snapping turtle is a robust turtle with an average carapace length of 8 to19 inches. The maximum weight, measured for an individual in captivity, is 86 lbs (Conant and Collins, 1998). The posterior edge of the carapace is serrated, any projections on the dorsal scutes do not form keeled ridges, and there is only a single row of marginal scutes. The plastron is small in size in proportion to the carapace and rest of the body. The tail is very long, as long as or longer than the carapace, and only has a single series of elongated dorsal scales, giving it a saw-toothed appearance (Ernst et al., 1994). Juvenile snapping turtles are darker, almost black, and tend to have a more rugose carapace than adults (Conant and Collins, 1998).

The snapping turtle is an adaptable, highly aquatic turtle that inhabits almost any body of water (including brackish). It rarely comes out of the water to bask, yet often wanders on extensive overland forays (Babcock, 1919; Gibbons and Semlitsch, 1991; Ernst et al., 1994). Snapping turtles are generalized omnivores eating any invertebrate, vertebrate, aquatic plant, or carrion that they can grab and swallow (Ernst and Barbour, 1989; Ernst et al., 1994). Snapping turtles in northern regions have a high tolerance to cold, and occasionally can be seen crawling along beneath ice in winter (Ernst et al., 1994; Somma, personal observation). Female snapping turtles lay 6-104 eggs in soil, rotting vegetation, sawdust piles, or muskrat and beaver lodges, during spring or summer (Ernst et al., 1994). A considerable amount of research has been performed on the physiological ecology of snapping turtle eggs, embryos, and nests, and best reviewed by Packard and Packard (1988), Ernst et al. (1994), and Rimkus et al. (2002).

Taxonomy

The taxonomy of *C. serpentina* has been reviewed or summarized by several authors (Ernst et al., 1988, 1994; Gibbons et al., 1988; King and Burke, 1989; Iverson et al., 2000). Several authors have discussed the taxonomic status of the subspecies of snapping turtles, even suggesting recognizing the currently described subspecies as full species as few intergrades exist between them (reviewed by King and Burke, 1989; Ernst et al., 1994). Iverson et al. (2000) now recommend using the standard English name "snapping turtle" rather than "common snapping turtle" as the latter implies that these turtles are abundant rather than having a broad range. A variety of other vernacular names exist for *C. serpentina* in other countries and have been summarized by Mittermeier et al. (1980) and Liner (1994). Reviews of the literature, natural history, and physiology of *C.*

serpentina have been summarized by Babcock (1919), Gibbons et al. (1988), Gibbons and Semlitsch (1991), and Ernst et al. (1994).

Two weakly defined subspecies (geographic races) occur in the United States (Gibbons et al., 1988; Conant and Collins, 1998; Iverson et al., 2000): *Chelydra serpentina serpentina* (Linnaeus, 1758), the Eastern Snapping Turtle, and *C. s. osceola* (Stejneger, 1918), the Florida Snapping Turtle. Unlike the Eastern Snapping Turtle, *C. s. osceola* tends to have longer, more pointed tubercles on the neck (Ernst et al., 1994; Conant and Collins, 1998).

Pertinent Biology & Ecology

Snapping turtles are ectothermic; they do not produce their own body heat, but draw warmth from the environment. Snapping turtles regulate their body temperature at approximately 82.5 F (28.1°C) by basking or sunning themselves.

Like other reptiles, snapping turtles lay eggs. The sex of a snapping turtle is determined by the temperature at which the eggs are incubated. Warmer incubation temperatures yield more female turtles. Hatchlings are about the size of a quarter when they emerge from their egg. Male snapping turtles tend to be larger than females with carapace length of female snapping turtles averaging 11 inches and carapace length of male snapping turtles averaging 13.3 inches (10). Growth rates in northern populations are slower and body sizes larger than in southern populations (55). The largest snapping turtle ever recorded from the wild was 18.5 in carapace length (5). Average weight for individuals ranging from 8-14 inches carapace length is 35 to 45 pounds (11). The heaviest snapping turtle ever caught in the wild weighed 68 lbs (12). The older snapping turtles get, the slower they grow, so the biggest individuals are possibly over 100 years old (10) It is possible to determine from the rings on the shell how old a snapping turtle is (10) (55) The oldest observed age for snapping turtles is about 75 years (11), while the oldest age based on ring counts was 79 years (9). Since growth continues throughout life, very old individuals can conceivably grow very large (13).

Snapping turtles can not hide as well in their shells as other turtles can, but have much better mobility. When they walk on land they can raise their body up from the ground, and only their tail is dragging (2).

The head of snapping turtles is approximately triangular, and the mouth is large, with sharp jaw surfaces adapted mostly for cutting (5). Turtles have no teeth (9). Several barbles are located on the chin (5). Those probably serve as an increased surface for oxygen uptake (9). The neck is very long (about as long as the carapace), and so is the tail which has three rows of spines (tubercules) on the upper (dorsal) side.

Snapping turtles are a bottom walking species, which means that instead of swimming they crawl or bounce along over the bottom in shallow water (11). The four legs are very short and massive with large curved scales on the front edges (5). As a turtle moves forward the scales on their legs lie flat against the skin, but when it pushes backwards in a swimming motion the scales stand up and provide an increased surface to push against (9). The feet are webbed and about as large as a human hand in large individuals. They have five claws on each of the two front feet and four claws on each of the hind feet (9). They can only float as long as they hold a significant amount of air in their lungs (9).

The underside (ventral side) of snapping turtles is very delicate and soft, and covered with numerous papillae again to increase the area for oxygen uptake (5, 9). The coloration of snapping turtles ranges from almost black to light coffee brown for all the dorsal surfaces. The soft skin underneath is yellowish to light brownish, sometimes even with a reddish tinge. The jaws have black stripes (5, 9).

Males and females look very similar although females have their cloacal opening (the combined opening for both the excretory and reproductive system) much further forward (5). A mathematical relationship can usually be used to identify the sexes, but pollution with persistent environmental chemicals changes this characteristic making identification difficult if not impossible (9, 56). Because of their longer period of optimum growth and higher survival males generally tend to be larger than females (most females are killed on roads during nesting migrations after only a few years of nesting) (9).

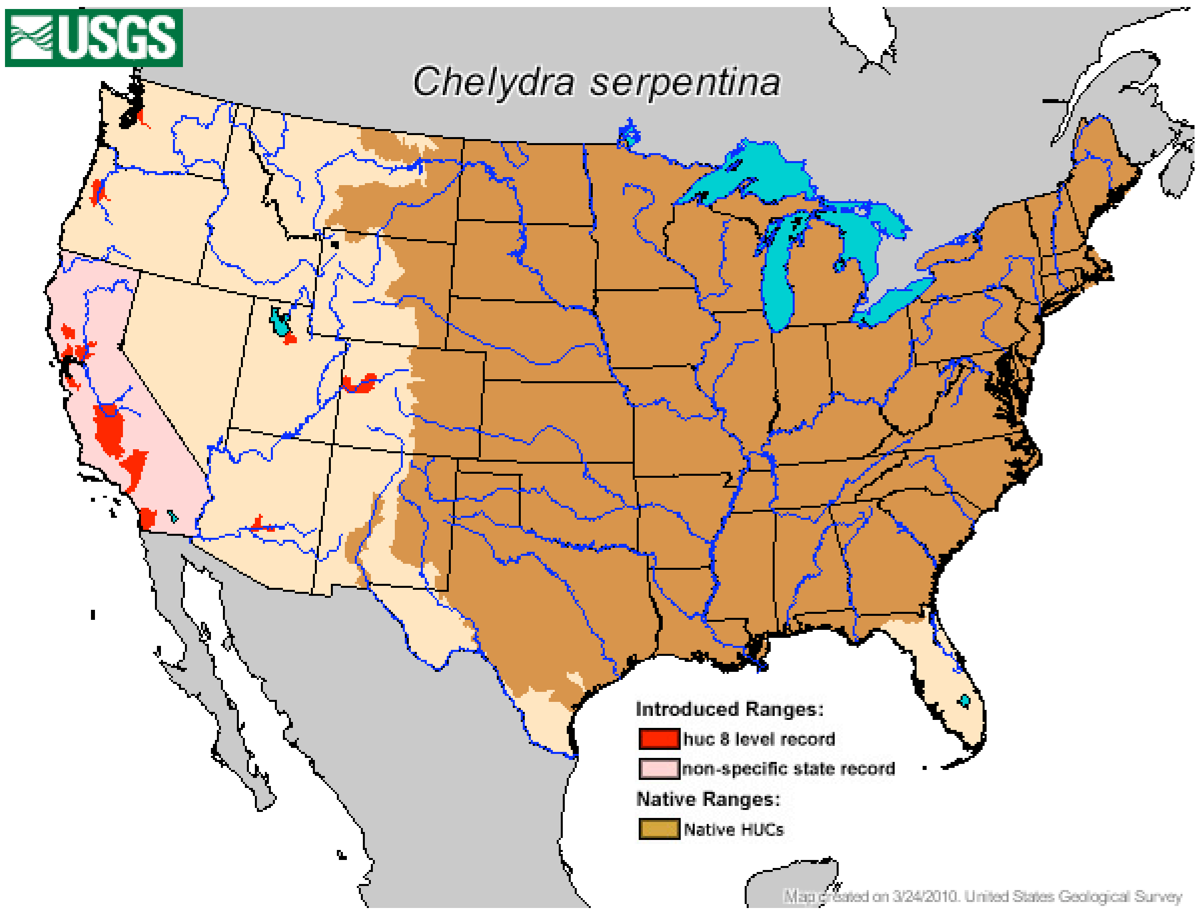
Snapping turtles have extremely good eyesight both above and under water. They can even see straight above their heads because of the position of their eyes (2, 9). They also hear very well. Their ears are located in the normal location on the skull, but lack external structures and are therefore not readily visible (9). Anecdotal accounts also testify to the fact that snapping turtles probably have an extremely good sense of smell or taste (9).

Food and Food Acquisition

Snapping turtles are omnivorous (2). The main and most important part of their diet is aquatic vegetation (65%) (11, 13, 16, 34). The second most important part of their diet is animal material including fish. About one-third of the snapping turtle’s diet is comprised fish (34, 35, 36; Congdon et al. 1986). Snapping turtles are capable of taking slow non-game fish, but appear to be no hazard to game and sport fish (1, 13, 23, 34, 35, 36). They also eat carrion, invertebrates (mollusks, crustaceans, worms, and insects), frogs, salamanders, reptiles including small turtles, water fowl and other birds, and small mammals (12, 16, 34; Ernst 1994). Live prey is mostly eaten in the spring when vegetation is still sparse, and by juveniles (6, 33). Once aquatic vegetation is available in the summer, it forms the main part of the adult’s diet (6, 33). Feeding starts once the water temperature rises above 16°C (6). Snapping turtle eat only once their body weight in food per year (20).

The hunting technique of snapping turtles involves very little active movement. Snapping turtles usually forage on the bottom or lie still in the mud, waiting for something to swim by close. Even when they are lying still, snappers can still see perfectly what is above their heads. When they stalk prey they move extremely slowly, with the skin on their legs and between their toes folding to the body during the forward motion to reduce drag. Once they strike the hooks on their jaw hold the prey firmly (2).

Native Range
Chelydra serpentina is a widely distributed turtle; its indigenous range encompasses the entire eastern and central United States from southern Canada, including Nova Scotia and southern and eastern Maine, southward to the Gulf of Mexico; from the Atlantic Coast westward to the eastern base of the Rocky Mountains in Montana, Wyoming, Colorado, and New Mexico. Snapping turtles found in peninsular Florida and extreme south-central Georgia are generally considered *C. s. osceola*. Other races of *C. serpentina* occur in a disjunctive distributional pattern from southern Mexico southward through Central America to western Ecuador.



Habitat Use
Snapping turtles are highly aquatic and spend most of their lives in the water, except when females are in search of suitable nesting habitat. Snapping turtles in the northern part of their native range have been observed basking (14). They prefer obstructed or covered areas to live in and prefer the bottom of rivers and lakes with soft mud (very important), organic debris, dense vegetation, and water lilies. However, they can readily adapt to a wide variety of habitats and are found practically in any permanent or semi-

permanent non-moving or slow-moving body of water (ponds, lakes, marshes, swamps, ditches, puddles, salt marshes), as long as the water depth is great enough to allow them to hibernate below the ice, and cover or camouflage is available (6, 11, 18). Snapping turtles live a sedentary life style (2, 16). They prefer to be able to reach the surface with their head while sitting on the bottom, and are therefore usually found only in water up to 3 feet (1m) deep, with depth of only 20 inches (50 cm) preferred in many cases, and a maximum possible water depth of 8 feet (2.5 m) (they only swim across deep areas but do not live in them) (6, 16, 17). Hatchlings and juveniles live in small streams with very shallow water and densely vegetated areas where they can reach the surface while standing on the bottom (up to 20 inches / 50 cm in depth for larger juveniles) (6, 15, 19). Both hatchlings and juveniles are poor swimmers, and all snapping turtles can drown if the can no longer reach the surface (19). As the turtles mature they migrate to ponds, rivers, marshes, and the shallow areas of large lakes to establish their adult territory (6). Adults generally avoid the shallow juvenile and hatchling habitats, a behavior called habitat partitioning (15). Snapping turtles can go for up to 2 weeks without water, which enables them to make long overland migrations, or to swim in the ocean (6). They can even live in salt water or brackish water but have to periodically return to fresh water to rehydrate (6, 20). Snapping turtles are one of the few species, which can also live in significantly polluted habitats, including sewer systems (21).

Population Densities

Density is negative correlated with latitude (24). This is probably due to two factors: lower reproductive success (and other life history constraints discussed later) further north, and less primary productivity (plant and subsequent animal growth) in the water (10, 23, 24). Reproductive success is determined by predation pressure on nests and hatchlings, climatic influences on hatching success, and nest-site availability (23). Density has been found to be generally higher in high productivity marshes and ponds (especially eutrophic systems) than in low productivity lakes and bogs (mesotrophic to oligotrophic systems) (24). The highest observed densities for eutrophic ponds were 66 individuals per hectare (24). Densities appear to be higher in smaller bodies of water than in larger ones (23).

Territoriality

Large (over 10 kg) male snapping turtles have fixed home ranges, which are avoided by smaller individuals (2). They show high fidelity to those and stay often in exactly the same spot for many years (over 10 years have been observed) (16, 17, 20, 27). The largest males are the most sedentary ones (20, 28). They will even return to exactly the same location over several miles if relocated (13, 29). Long distance movements for males would be disadvantageous since fewer females might be present in a different area, so they do not disperse (16, 17). Home range boundaries are re-determined each spring by size-based dominance and aggressive interactions. (10, 27) Spacing is probably also determined by aggressive interactions (27). Large males dominate smaller males within their territory to insure their own mating success (10). The most desirable locations are those through which females migrate on their way to the nesting sites (16). The territoriality of large males increases the dispersal of immature individuals and regulates densities (20). Smaller males sometimes live in the same lake year after year, but do not maintain the same home range. Often sub-adult males and small adult males tend to disperse to different areas, especially when they approach maturity and get ready to establish their own home territory (20, 27). Home ranges for both sexes can overlap extensively (15, 16).

Home ranges range from about 3.2 m^2 to 8.9 ha in size (15, 16, 17, 20, 27). Large males generally hold larger home ranges than smaller males (20). Home range size appears to be similar for males and females (17). In northern populations home ranges are relatively large (approximately 3.4 ha) (17). Home ranges in small lakes are generally smaller (0.70 ha) than in large lakes (3.2 ha). In a large lake home ranges are arranged along the shores with an occasional crossing to the other side (27).

Females are more mobile than males (30). In many cases they occupy the same home range year after year, in others they shift home ranges after nesting, or have very large home ranges and occupy different parts of them in different years (16, 17). Some females are believed to be transient and without fixed home ranges. Those individuals only nest once in one location and then move on (28). Adult females are believed to be the dispersal stage for snapping turtles (16). Since they can retain sperm in their body for many years, females do not need to find mates every year to reproduce, and dispersal is not disadvantageous for them (16, 17).

Home range preferences also depend on size and age. Juveniles for example prefer weedy shallows (2). When water levels are unstable home ranges also shift constantly as turtles move out of areas which are drying up (16). When whole ponds dry up its inhabitants will move over land to the next water. Those migrations are usually very quick, and individuals move up to 620 yards (567 m) in 2.5 hours. Roadways are often utilized to facilitate migrations (31). In tide marshes snapping turtles move between a summer habitat and a winter habitat (20). Home ranges which have become unsuitable are also left. For example the surviving turtles emigrated from a lake after extensive otter predation has occurred (28). Home range fidelity appears to increase with age (15). Both immature turtles and small adults seem to tend to disperse, since they are often seen in semi-permanent bodies of water or on land far from any permanent habitat (20).

Snapping turtles do require permanent bodies of water to survive, but can survive without water for at least two weeks. This allows them to make extensive terrestrial migrations from one body of water to the other and to also migrate through salt water to coastal islands and into estuaries (6, 11, 12). Still the rate of immigration appears to be extremely low in snapping turtle populations. (1 to 2 % annually) (12, 32). Since hatchlings and juveniles live in tributary streams a significant amount of this immigration rate will be young individuals from upstream (12, 33). Hatchlings and juveniles are too small to move against a current and probably slowly make their way down into the lakes as they mature (12). Larger turtles often move into an area from downstream (12).

Life History Parameters

Snapping turtles have a problematic life history. Once snapping turtles reach about 3 inches carapace length, they have no more natural predators. Because the survival of eggs and juveniles is so low, that only a few in a thousand make it, adults have to lay many eggs over their lifetime to successfully reproduce (10).

Life Expectancy - Because adults have no natural enemies, they usually live a long life and die of old age, usually during the winter (10). Annual adult survivorship is 93 to 97%, and confirmed annual adult mortality ranges from less than 1 to1.3%, which means that 60% of the individuals reaching maturity will live to age 50 (10, 28, 30, 32, 48). Unlike in any other species survivorship does not decrease with age (10). The maximum theoretical longevity is 170 years, and longevities over 100 years can be expected especially in the northern populations where the activity season is shorter (10, 11, 42). Lifespans of over 75 years have been observed (11).

Reproductive Age and Output - A positive correlation exists between female body size and the number of eggs which can be laid in any given year (10). To maximize survival and therefore lifetime reproductive output, females have a constantly low reproductive effort with each clutch being only about 7% of their body mass (10). Depending on size, this translates into 11 to 87 eggs, with a mean clutch size of 28-49 (2, 11, 12, 20, 32, 41, 42, 49). Mean clutch size for northern population is 34 (55). Clutch size relative to body size stays constant year after year. This enables the turtles to retain enough energy to survive through the winter (10). Snapping turtles also conserve energy by not reproducing ever year (reproductive frequency 0.85), and only about 72% of the females lay a clutch every year (13, 23, 32). It is unclear if and how females choose the years when they will reproduce if the do not do so annually, and climate might possibly play a role (13). To maximize the number of eggs that can be laid during a lifetime, a large body size at maturity becomes important, because once a female starts laying eggs her growth slows down due to her energy investment into the eggs (10). So it is selectively advantageous to start laying more eggs later than to start sooner with fewer eggs (10). A larger and older female will be able to lay large clutches for the remainder of its life, which in an undisturbed system would be very long (30). Snapping turtles delay their maturity until their initial clutch size will be about 22 eggs (10). Because females are selected for an ideal body size at maturity, male body size will follow since males have to be capable of mating with females and since it would be a waste of energy for them to be ready to mate while the female of the right size was still immature (10). Males fight for dominance and forcibly inseminate females, so a large size at maturity is also necessary for them (10). Consequently snapping turtles reach maturity only at the relatively large size of 20-25 cm. This size may be the minimum length at which enough energy is present to support both reproduction and survival, especially in a northern population with an extended wintering period (10, 50, 51, 55). In northern areas this takes approximately 12-19 years for males and approximately 11 to 19 years for females, with age at first nesting being generally around 19 years (10, 19, 23, 32, 52, 55). Generally faster growth rates in males may result in a slightly earlier maturity than in females (10). The average age of reproducing females is even higher, 34 - 40 years in northern populations (1, 24, 28, 52). In comparison, by the time a snapping turtle nests for the first time, more than 10 generations will have passed for a deer. Further south growth is faster and age at maturity already occurs at age 4 to 12 (2, 10, 12, 13, 33, 42, 44, 51). Size at maturity however stays the same (42, 51). There the age of nesting females might range from 8 to 24 (13). Clutch sizes also increase with latitude, indicating that in northern populations a large body size at maturity with a resulting larger clutch size and a longer reproductive lifespan were favored over earlier maturity as it occurs further south (30).

Reproductive Success **-** Reproductive success is highly variable due to the unpredictable environment. Especially the weather during the incubation period plays an important role since embryos develop only at temperatures above 20° C. (10, 13) Because snapping turtles have TDS (temperature dependent sex determination) an incubation temperature of exactly 28°C is necessary to maintain a 50:50 sex ratio. (2, 53) In northern populations short cool summers with high amounts of precipitation cause frequent years with complete reproductive failures. (12, 24, 30, 42, 45) However, because survival from year to year is naturally so high for adults, reproductive failures in one year have normally little impact on lifetime reproductive success and population stability (this of course holds no longer true if adult mortality increases). (42) Nests will also fail to hatch if they are located in a shaded area. (42) Predation on nests is also extremely high. An average of 11 to 94 % of nests are annually destroyed by mammalian predators (skunks, raccoons, mink, red foxes), but yearly variation is high. (10, 12, 20, 23, 30, 42, 45) Especially favored nesting areas where many turtles nest together in a small area are vulnerable to predation, while isolated nests often stay undisturbed. (13) Only about 14% of all clutches emerge annually (3-36%) (10, 13, 45) This low reproductive success is probably the factor which keeps densities in northern populations so low. (24) However, the lucky undisturbed nests in good years can produce up to 50 hatchlings. (2) Still only about 15 hatchlings will leave a successful nest (emergence success is only about 20 to 45%). If the air and surface temperature is too low hatchlings attempt to over-winter in the nest, a strategy which is successful in the south, where even the un-hatched eggs can over-winter. (6, 10, 12, 13, 42) In the north this strategy is fatal, and the hatchlings freeze to death. (2, 30, 45) The northern extent of the species is therefore limited by summers which are long enough for hatching or soil which stays above freezing to allow eggs and hatchlings to over-winter. (2) All those factors together cause huge fluctuations in reproductive success from year to year. (23) It is possible that only one year of ideal climatic conditions for nesting and hatching out of 5 to 10 may be enough to maintain or increase the population, (12) but only if nest predation is also low in that year. Predation on hatchlings and juveniles is still heavy especially during the first year, and only slightly lower during the 2nd and 3rd year. (12) They get eaten by raccoons, mink, weasel, skunks, herons, and large fish while they are still less than three inches (7.6 cm) in length. (2) (23, 52) The probability of survival from egg to adulthood is 1 in 1445 individuals, the probability of survival from hatching to adulthood 1 in 133. (23, 28) This results for female snappers in a probability of death between hatching and breeding age of 99.17%. (23) Annual recruitment into the breeding population (the number of juveniles reaching maturity in any given year) is only 1 to 1.8%. (28, 52)

Reproductive Strategy **-** In the northern parts of their range snapping turtles have a reproductive strategy which scientists call bet-hedging. Its characteristics are high and fluctuating egg mortality, highly variable density independent juvenile mortality, but low and constant adult mortality (long life), delayed maturity, low reproductive effort, annual reproduction, constant reproductive output independent of environmental factors, and smaller than maximum possible clutches. This is generally a response to an unpredictable and highly fluctuating environment, since an individual, which will reproduce with the same amount of effort every year will have a higher probability of actually reproducing during the infrequent favorable years where the whole clutch will survive. (10, 30, 32) While delayed sexual maturity, greater size at first reproduction, and long lifespan give the benefit of an increased number of young per reproductive cycle, a better quality of young (better chance of survival), a decreased reproductive cost, and a consequently decreased mortality as an adult, it also has two distinct costs: the risk of death prior to first reproduction and longer generation times. Adults have to live and reproduce for a long time to keep population levels stable. Enough juveniles have to survive until maturity to eventually replace the adults. (28, 30, 32) The distinct advantage of this strategy is enhanced lifetime reproductive success. In a system where nest predation is so high and unpredictable selection favors females, which divert energy from reproduction into survival and have many small clutches over their lifetime. (30) Size at maturity becomes a much more important factor in lifetime reproductive output than age at first reproduction since in populations with a low rate of increase there is very little effect of small clutches early in life. (10, 52) The strategy is called bet hedging because it literally means saving your bets for later. A species which lives only for a short time and dies soon (such as rabbits) need relatively stable conditions to insure that at least two of their offspring will survive to reproduce again (genes continue on if the mother and the male are replaced by two offspring). Since snapping turtles in the north cannot predict which year will be favorable and allow their clutches to hatch, it doesn’t make sense for them to put their whole lifetime reproductive output into a few years at a small size and die young, since just those young might not make it. But if they instead delay maturity until their body is large enough to support reproduction without reducing the chance of survival, they can possibly lay eggs over maybe 60 to 100 years and be reasonably sure that a few of those will hatch in a summer where the weather is good and nest predation low. But this strategy only works as long as adult mortality is very low. As soon as it increases, adults will die without reproducing, and extinction will occur. It is therefore clear that with this reproductive strategy, adults which die prematurely cannot be replaced. (28) This is especially true since populations with these life history parameters do not have density dependent reproductive responses, which means that a decline in adults will not lead to an increased survival of young, increased recruitment of adults, earlier age at maturity, or greater reproductive output. Most mammalian species can do several of those things to compensate for increased mortality. (28) Therefore this species is basically predisposed to extinction, since it is extremely susceptible to increased adult mortality. (28) The bet-hedging strategy was capable of bringing snapping turtles through several ice ages and climatic shifts since it is simply a constant slow waiting for better conditions, which individuals with such long life spans can afford. Since they evolved there was only one factor which snapping turtles never had to face: adult death. Due to the increased killings of adults in our time (road mortality as well as harvesting) the whole strategy falls apart, and reproduction does in many cases not occur before the female dies. Protection of adults is therefore the most important conservation issue. (32) Studies have found that snapping turtle populations in the north are apparently non-sustainable and rely on immigration from other areas. (12) Statistical tables of survival data have also shown that northern populations do not reproduce enough to even continue to exist. (23) One possible explanation is that we are already looking at a slow continuous population decline.

Interactions with Waterfowl

It is frequently believed that snapping turtles have a significant impact on waterfowl populations. In fact research indicates that turtles present no hazard to waterfowl populations. (23, 36) Birds are only an incidental food and rarely taken, and even then only in localized areas. The frequency of birds in the diet varies widely depending on the habitat. (34, 35, 37) The only instances where snapping turtles do impact waterfowl is in localized spots where turtle densities are very high and access to young waterfowl is easy, such as shallow streams with high bird densities. (23, 34) Even in those areas only a small percentage of the duckling population is killed. (13, 34) Even if turtle densities are reduced to below 0.1 turtles per acre (0.24/ha), duck brood survival increases only minimally. (13) Turtle densities of more than 0.5 turtles per acre (1.3/ha) used to be considered detrimental for waterfowl populations, but an extensive study failed to find any differences in brood size and survival of birds between areas where snapping turtle densities had been reduced to 0 and areas where they had been left at natural levels. Only if snapping turtle populations are artificially raised to more than twice their natural density do they begin to have a small impact, which might then be due to exceeded carrying capacities. (13) It turns out that external forces such as weather have a much higher influence on waterfowl brood survival than turtle predation. (13) In many areas waterfowl populations also peak before turtles even begin to feed and are therefore definitely not impacted. (20) Studies performed on turtle - waterfowl interactions have found that control of turtles would be undesirable and impractical (34). While turtles have practically no impact on waterfowl populations, turtle control has a hugely negative impact on the turtles since mostly nesting females are eradicated. Annual mortality rises suddenly sharply from the age of maturity on from about 1% before the onset of nesting to 47% for a mature female. In comparison the mortality rates for males stay at a normal 4%. This skews the sex ratio dramatically towards males. (13) If in isolated cases an agency wants to control turtle populations it should be considered that large males, not females are the most important predators on birds. They could easily be hand-captured by divers and moved to locations where lower waterfowl populations exist. (20)

Harvest and Tapping

Snapping turtles are frequently trapped. Because they are seen as competitors for game fish and waterfowl, there are no adequate laws protecting them. Stocks are completely unknown, and trapping virtually unregulated. (28) In Maine, for example the number of snapping turtles which can be taken is unlimited. A free commercial trapping permit is only required if the turtles are sold. The only protective law existing for this species is that turtles can no longer be run down with a car. (ME Dpt. IFW pers. comm.) Every year 6000 to 8000 adults are trapped in Minnesota, 5000 to 8000 in southern Ontario. (23) 60,000 snapping turtles from all over the United States are each year killed in a slaughterhouse in Iowa. Demand for snapping turtle meat has increased dramatically since marine turtles and terrapins became protected. (1) According to Developing Management Guidelines for Snapping Turtles, a US Forest Service Report, the "northern population [of snapping turtles] cannot sustain even minimal exploitation by humans". (23) Other studies have also concluded that northern populations of snapping turtles need to be completely protected to continue to exist. (28) Long lived vertebrates in general have practically no resistance to increased adult or juvenile mortality, especially if they have delayed maturity and an increased reproductive lifespan. (32, 48) Because of the high juvenile mortality the removal of adults produces a decline in numbers, which cannot possibly be replaced by juvenile recruitment. Because of their life history parameters, which rely on adult longevity, snapping turtle populations cannot tolerate increased adult mortality. Harvesting or any form of exploitation could cause quick population crashes and recovery through reproduction would be extremely slow, or probably not possible at all. (23, 28) In fact the protection of adults and juveniles would be much more important than hatchling or nest protection. (32) Even an increase of adult mortality of only 10% annually would halve the number of adults in 15 years. (32) Even much more productive populations further south with a mean clutch size of 45 and an age at first nesting of 10 could only barely sustain an increase in adult mortality of 10%. (23) Historically especially hibernating turtles have been trapped, an especially destructive technique which very quickly destroys a population. (32) Trapping in general always removes the largest and most productive individuals, which cannot possibly be replaced. (6, 29) In areas which are regularly trapped especially females have a lower life expectancy since they are killed on their way to the nesting beaches. Almost all of the larger turtles which remain are males, which further decreases the reproductive output of the population. (20) In fact trappers have already reported drastic declines in northern populations where adults have been trapped. (23, 24) Studies have shown that snapping turtle harvesting activities generally halve the adult biomass within 4 years with recruitment being unable to compensate. (20) Major population declines from harvesting might also be masked for a few years through the growth of the remaining juveniles and their recruitment into the adult class, although no more reproduction is taking place because of the long generation time of this species. (32, 42) If harvest has to take place it should at least be restricted to small and medium-sized males and nesting females should be protected. (20)

Snapping turtles in many cases are also not be suitable for human consumption since they carry extremely high loads of persistent environmental pollutants such as PCBs (up to 10,000 ppm were for example found in their fat, brain tissue, and testes). Those levels would be immediately deadly for a human. (20, 23, 54)

Aggression and Danger to Humans

Snapping turtles are not as aggressive as most people believe. They will defend themselves if cornered and cut off from the water by striking out with their head, which can reach almost all the way back along the shell. In the water, snapping turtles will always leave instead of attack. Snappers do not attack people in the water (2). Because of their position in the food chain snapping turtles are not afraid, but they are also not aggressive. An annoyed snapping turtle will back into a corner and lunge at a human, stopping about an inch short. Only if you violate a very tight zone around a snapping turtles head with a small object (something it judges it could get its jaws around) while the turtle is annoyed it will sometimes strike, bite, and sometimes hold on. This can of course also happen if a snapping turtle is injured. If a snapping turtle does not feel threatened it will in most cases tolerate extensive handling including having its mouth and nose touched. Even if a turtle bites a person it has no intention of hurting them. Snapping turtles often "play bite" their conspecifics without injuring them. Many individuals are very curious and will approach swimmers or boats very closely. They examine things by touching them with their nose, so a very curious snapping turtle might bump a swimmer carefully. Their curiosity for boats often seems to cause injuries by the propellers, since especially turtles in lakes with high boat traffic frequently have scarred backs (9).

Nonindigenous Occurrences
According to the U.S. Geological Services' (USGS) Nonindingeous Aquatic Species (NAS) Fact Sheet for the snapping turtle, the species has been found and collected at in six western states outside its native range (Colorado, Nevada, Utah, Arizona, New Mexico and California) plus the Caribbean. In 1913, six snapping turtles were intentionally introduced to the Vancouver area of British Columbia, Canada (Gregory and Campbell, 1984). Snapping turtles are occasionally captured in the United Kingdom (Beebee and Griffiths, 2000). All nonindigenous records of snapping turtles are apparently the subspecies *C. s*. serpentina.
http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1225)

Population Status in Oregon
According to the USGS NAS Snapping Turtle Fact Sheet, the status of snapping turtles in Oregon remains unclear, but based on apparent reproduction in Seattle, Washington, the presence of scattered established colonies is suggested. The USGS NAS Fact Sheet for the snapping turtle indicates only two known collection sites in Oregon. Both collections occurred Lane County in 1993 - one from an unidentified water body in Eugene and the other from the Coast Fork Willamette River about one (1) mile east of Eugene (D. Holland, personal communication 1997). Additionally, as per the USGS NAS Fact Sheet for the snapping turtle, snapping turtles have been collected in Portland, Multnomah County; Corvallis, Benton County; Springfield, Lane County; Coos Bay, Coos County; and sighted in a pond near Roseburg, Douglas County (Brown et al., 1995). USGS NAS recommends intensive updated surveys be conducted to verify the status of the snapping turtle throughout the Pacific states and other western states. The USGS NAS acknowledges that nonindigenous occurrences of established populations of snapping turtles throughout the western U.S. are probably more extensive than what are reflected on their webpage

Oregon Department of Fish and Wildlife (ODFW) has compiled all known occurrences of snapping turtles within Oregon to date (see Attachment 1). In addition, ODFW has been conducting a snapping turtle capture and removal from the wild effort in the Portland metropolitan area since 2004. Capture / removal efforts are targeting the only known successfully reproducing population in the state, that being Koll Wetland in Beaverton, Washington County (Barnes, pers. comm. 2010). Koll Wetland is a 20-acre wetland area owned and managed by the Washington County's Tualatin Hills Park & Recreation District. It located immediately adjacent to Fanno Creek, a tributary to the Tualatin River. Snapping turtles have been observed / collected from both Fanno Creek and the Tualatin River. Snapping turtles also occur in other tributaries of the Tualatin River, a waterbody known for its year-round sluggish waters and warm water temperatures. Snapping turtle reproduction is suspected to occur in other parts of the state, particularly within the Tualatin and Willamette River drainages, but specific nesting sites have not yet been located. In addition to targeted capture / removal from the wild efforts by ODFW at Koll Wetland, increased awareness about snapping turtles and invasive species has led to multiple incidental captures throughout the Willamette Valley. Captures have occurred primarily near urban centers (Portland, Corvallis, Eugene). Most captures have been of gravid female turtles caught on land, apparently turtles in search of suitable nesting sites.

To date, according to ODFW (Barnes, 2010) snapping turtles have been observed and / or collected from the following locations within Oregon:

County	Nearest Waterbody	Nearest City	# Turtles
Clackamas	Clackamas River	Estacada	1
Washington	Koll Wetland / Fanno Crk	Beaverton	69*
Clackamas	Lake Oswego	Lake Oswego	1
Clackamas	River Forest Lake / Will. R.	Oak Grove	1
Multnomah	Sandy River	Troutdale	1
Clackamas	Will. R. / Kellogg Lake	Milwaukie	2
Washington	Rock Creek	Hillsboro	1
Lane	Creswell Lake	Creswell	2
Washington	Fanno Creek	Beaverton	1
Multnomah	Columbia River	Portland	1
Washington	Summer Creek / Lake	Tigard	2
Multnomah	none (urban residential)	Portland	1
Benton	Owl Creek / Will. R.	Corvallis	1
Washington	Tualatin River	Hillsboro	1
Linn	South Santiam River	Lebanon	1

*confirmed breeding population (multiple nests excavated and eggs collected)

Summary of Snapping Turtle Capture / Removal Effort at Koll Wetland, Beaverton, Washington County.

Several methods of capture have been tested since 2004 - live trapping, jugging with single jug, jugging on trot line, and land searches for gravid / nesting females. Bait preference was tested. Other data collected included: water temperature, air temperature, water depth, vegetation characteristics, weather, date of capture effort, and time expended.

<u>Key Findings:</u>

- Fish bait (e.g., carp) was preferred over non-fish bait.
- Though Koll Wetland appears to uniform in nature in terms of water depth, water temperature, and vegetation, certain areas of the wetland yielded more turtles. Weather seems to affect turtle activity, with the exception of onset of nesting activity.
- Small turtles (less than 6 in carapace length) were difficult to sex from external characteristics. Dissection and evaluation of reproductive tract was determined to be the best technique to determine gender of small turtles.
- Land searches resulted in the capture of female turtles.
- Clutch size ranged from 29-65 eggs (mean = 52). Nests were within 50 feet of water (may be of a function of hardscape present nearby).
- Nests were located in hard compact soil under bark chips or in sandy soil near a volleyball court.
- Nesting activity mostly occurred in morning or evening hours.
- Most nesting activity occurred in early June and was completed by early July, but ranged from late May to early September.
- Nesting activity seemed to be affected by human activity level surrounding the wetland.
- Discovery of female snapping turtles on land seemed rather random.
- Nesting occurred in all weather events, even during heavy rain events.
- Other lessons learned related to management of invasive species, particularly in an urban environment:

- Information and education materials and outreach efforts are key to success and gaining public support of invasive species control.

- Volunteers are helpful, but have to be trained property, both in technique and in key public information messaging.

- Citizen science, such as on-line turtle sighting reporting, is an important and useful tool to aid EDRR.

Methods of Introduction into Oregon

- Pet Trade
- Pond Supply Industry
- Food Industry
- Intentional and Accidental Releases into the Wild

Federal and State Wildlife Laws Applicable to Snapping Turtles in Oregon
There are several federal and state laws that apply to snapping turtles in Oregon.

Federal Law

U.S. Fish and Wildlife Service, Lacey Act (1900) - Regulates possession, transportation and importation of injurious wildlife and prohibits trade in wildlife, fish, and plants that have been illegally taken, possessed, transported or sold. Thus, the Act underscores other federal, state, and foreign laws protecting wildlife by making it a separate offense to take, possess, transport, or sell wildlife that has been taken in violation of those laws. The Act prohibits the falsification of documents for most shipments of wildlife (a criminal penalty) and prohibits the failure to mark wildlife shipments (civil penalty).
http://www.fws.gov/le/pdffiles/lacey.pdf

Food and Drug Administration, Title 21, Part 1240) - Regulates the sale of turtles with a shell less than four inches long is illegal. Exceptions to FDA's regulation include sales of these turtles intended for export only or for bona fide scientific, educational, or exhibitional purpose. For more information on FDA's regulation of turtles, please see the following: http://www.fda.gov/cvm/turtleregs.htm

State Law

Oregon Revised Statute, 498.052 - States that no person shall release within this state any domestically raised wildlife or wildlife brought to this state from any place outside this state unless the person first obtains a permit therefore from the State Fish and Wildlife Commission .

Oregon Department of Agriculture, OAR 603-011-0420 - Regulates the import and sale of turtles. Turtles must measure more than four (4) inches across the carapace (shell) to be brought into Oregon. Smaller turtles may only be possessed by a governmental agency, privately funded research group or zoo or wildlife exhibits. Allows ODA to take samples of turtles, tankwater or other appropriate samples from turtles sold, distributed or given away and cause laboratory examinations to be made. In the event turtles, so sampled, are found contaminated with Salmonella the Department may order the immediate humane destruction of any or all of the lot of turtles from which the samples were obtained.
http://arcweb.sos.state.or.us/rules/OARS_600/OAR_603/603_011.html

Oregon Department of Agriculture, OAR 603-011-0382 **-** Regulates the importation of wildlife and cervids. This rule applies to all wildlife species whether raised in captivity or wild captured, excluding domesticated fur bearing animals as defined in ORS 596.020(2). In addition to the requirements of OAR 603-011-0255 relating to the importation of animals into Oregon, no person shall ship, move, or import any wildlife into this state without complying with provisions outlined in this OAR to ensure health of the wildlife. http://arcweb.sos.state.or.us/rules/OARS_600/OAR_603/603_011.html

Oregon Department of Fish and Wildlife, OAR 635-056 - Regulates non-native species in Oregon in order to protect Oregon's native species. The snapping turtle is classified as Non-Native Prohibited Wildlife. Prohibited species may not be imported, possessed, sold, purchased, exchanged or transported in the state unless a permit is issued by ODFW to do so. http://www.dfw.state.or.us/OARs/56.pdf

Establishment Potential and Spread Potential: HIGH

Once introduced into the Oregon's wilds, snapping turtles can disperse quickly to suitable waterways, particularly in western Oregon. Spread potential in Eastern Oregon is considered slightly lower due to less abundant rivers and streams. Snapping turtles appear to easily tolerate the Pacific Northwest's climate and are known to successfully reproduce in the Willamette River Valley in one location (Beaverton, Washington County). Additional reproductive populations in the Willamette River and tributaries are very likely as they are known to occur in the major waterways and can easily travel through the system within the rivers and streams. Snapping turtles are very adept swimmers and even on land can move quickly.

Potential for spread is also considered high because snapping turtles are habitat generalists, have a varied omnivorous diet, can tolerate a variety of water temperatures. Although mortality rates of eggs and hatchlings are relatively high as with all turtle species, snapping turtles have a very long life expectancy and high reproductive potential. Adult snapping turtle have no natural predators. Their external appearance is rather intimidating; the general public does not feel comfortable or have the skills necessary to handle snapping turtles on found land or in the water. Thus, potential escape even if found is high. Snapping turtles are very cryptic in appearance and nature so can go undetected for many years.

Snapping turtles have demonstrated the ability to establish and expand their distribution through human assisted transport. Although we do not know exactly when or where snapping turtles were first introduced into Oregon or how often or where subsequent releases have occurred, it is highly suspected that snapping turtles were brought to Oregon through the pet trade and food industry. We do know that various non-native turtle species, including snapping turtles, continue to enter Oregon via individual citizens moving from other parts of the country and out-of-state pet turtle internet sales.

Known eradication techniques (trapping using various methods and land searches for gravid females) are feasible and effective, but overall very time consuming and require much effort.

<u>Economic Impact Potential in Oregon: LOW</u>
In Oregon the economic impact would be relatively low. But due to the misinformation that the general public may have about these animal and perceived fears of these animals by the public in the snapping turtles native range some negative economic impact maybe attributed to their presents in Oregon.

Snapping turtle have relatively low economic important within their native range. Although they are a food source for some people, the snapping turtle is a species of conservation concern in portions of its native range. Accordingly, measures are being taken by state fish and wildlife management agencies to protect and conserve remaining populations.

Possible economic effects here re in Oregon would b, if they were to occur, would be most likely related to conservation of Oregon's native fish and wildlife of species of conservation concern (native reptiles, amphibians and fish). This would only occur if it was determined that the snapping turtle was affecting population sustainability of those species. Studies to investigate this possibility have not been conducted.

<u>Environmental Impact:</u> UNKNOWN
The impact of nonindigenous *C. serpentina* in the western U.S. is entirely unknown, but in the Pacific states where there are few species of indigenous freshwater turtles (Stebbins, 1985; Brown et al., 1995), their impact might be negative. These adaptable, omnivorous generalists could further impact indigenous, especially endemic, fauna and flora by the introduction of disease or direct competition for food and habitat if they spread throughout these states. There is potential for reduction in biological in localized populations of native species of native species of conservation concern (reptiles and amphibian, fish). Potential for spread of disease from newly introduced snapping turtles.

<u>Final Score "Relative" Risk Rating</u>: MODERATE, HIGH or VERY HIGH

The final score "Relative" Risk Rating for snapping turtle in Oregon is undeterminable at this time due to the **UNKNOWN** rating for the Environmental Impact Criterion.

- If this Environmental Impact Criterion is **LOW** then overall risk rating is **MODERATE**
- If this Environmental Impact Criterion is **MODERATE** then overall risk rating is **HIGH**
- If this Environmental Impact Criterion is **HIGH** then overall risk rating is **VERY HIGH**

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