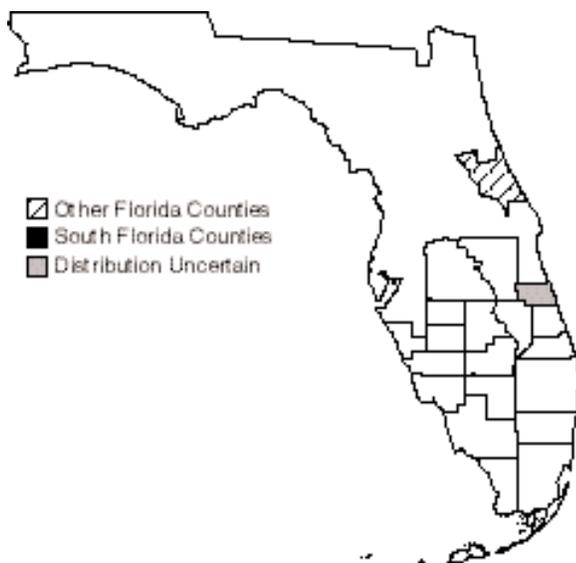

Atlantic Salt Marsh Snake

Nerodia clarkii taeniata

Federal Status:	Threatened (Nov. 29, 1977)
Critical Habitat:	None Designated
Florida Status:	Threatened
Recovery Plan Status:	Contribution (May 1999)
Geographic Coverage:	South Florida

Figure 1. County distribution of the Atlantic salt marsh snake; this species is only found in coastal habitats within its range.



The Atlantic salt marsh snake (*Nerodia clarkii taeniata*) is a small, slender snake that inhabits coastal salt marshes and mangrove swamps that vary in salinity from brackish to full strength seawater. It is unique because it is one of the few North American reptiles that lives in salt water habitats but has not developed salt glands. The Atlantic salt marsh snake was listed as a threatened species due to habitat loss and alteration, and potential hybridization with adjacent freshwater species.

This account represents South Florida's contribution to the range-wide recovery plan for the Atlantic salt marsh snake (FWS 1993).

Description

There are three subspecies of salt marsh snakes: the Gulf salt marsh snake (*Nerodia clarkii clarkii*), mangrove water snake (*N. c. compressicauda*), and Atlantic salt marsh snake (*N. c. taeniata*). These subspecies are distinguishable as follows: their dorsal patterns are formed from a basic pattern of four rows of dark blotches running from head to tail (two lateral and two dorsolateral rows) on a lighter background. In the striped forms, the blotches fuse linearly to form stripes; in the banded forms, the blotches fuse across the back to form bands. In partially striped individuals, it is invariably the anterior portion of the body that is striped, with the pattern posteriorly consisting of bands or rows of unfused blotches. The lateral stripes have a greater tendency than do the dorsolateral stripes to break down posteriorly into rows of blotches.

The Gulf salt marsh snake has a dorsal pattern that is completely striped, or nearly so, with dark brown to black stripes on a tan background. It is not unusual for the lateral stripes in this form to break down posteriorly into rows of blotches. The mangrove water snake may be uniformly orange in color, but it more often has a pattern of dark bands on a lighter background. Individuals from throughout the range of the mangrove water snake may be

partially striped; in these specimens the striping is typically limited to the neck region, but occasional specimens may be more extensively striped. Coloration in the mangrove water snake is extremely variable, with the background being gray, straw, or reddish and the bands being black, brown, or red. Populations of mangrove water snakes characteristically include at least some individuals that exhibit reddish or orange pigmentation.

The Atlantic salt marsh snake is a partially striped salt marsh snake that reaches a maximum length of at least 82 cm, although it is typically less than 65 cm in length. The pattern consists of a gray to pale olive background with black to dark brown stripes anteriorly, the stripes breaking up into rows of spots posteriorly. The extent of the striping is variable, but most individuals from the coastal marshes of Volusia County are striped on at least the anterior 30 percent of the body. The ventral is black with a central row of large cream to yellowish spots. As in the case of the dorsal striping, this ventral pattern is best developed anteriorly and tends to break down posteriorly. The red pigmentation characteristic of mangrove water snakes is conspicuously lacking in Atlantic salt marsh snakes from the vicinity of Edgewater, Volusia County, and northward (i.e., the area from which the form was described). The threatened designation applies only to the Atlantic salt marsh snake.

Hebrard (1979) reported coloration for 23 specimens from the southern Indian River Lagoon, near the Volusia-Brevard county line. Of these, seven (30 percent) exhibited orange or reddish pigmentation either dorsally or ventrally. It is unclear at this time whether the reddish pigmentation reported by Hebrard should be interpreted as indicating intergradation with the mangrove water snake. The series of 25 specimens for which Hebrard provided pattern descriptions had dorsal stripes on 0 to 100 percent of the body; only eight (32 percent) had dorsal stripes on more than 30 percent of the body, but three (12 percent) reportedly had dorsal stripes on 100 percent of the body. (In terms of pattern formation, the vertebral stripe is actually the lighter background color which is visible between the two dark, dorsolateral stripes.)

There are several characters of morphology and color pattern that distinguish the salt marsh snakes from the related freshwater species of *Nerodia*, but one of the most reliable is the number of dorsal scale rows. The salt marsh snakes have the dorsal scales in 21 rows at midbody, whereas the freshwater banded water snake has the scales in 23 rows. Also, those populations of salt marsh snakes that are at least partially striped are easily distinguished from the freshwater form, which is completely banded.

Taxonomy

Nerodia clarkii has a complex taxonomic history, having been known under various combinations of generic, specific, and subspecific names. The North American water snakes were long included within the genus *Natrix*, but Rossman and Eberle (1977) restricted that genus to Eurasia and erected the genus *Nerodia* to include many of the North American species previously included within *Natrix*.

At the species level, the salt marsh snakes have at various times been treated as a separate species or as subspecies of two related freshwater species. Both *Nerodia c. clarkii* and *N. c. compressicauda* were initially described as

Atlantic salt marsh snake.

Original photograph courtesy of
U.S. Fish and Wildlife Service.



separate species, based at least partly on reports of hybrids between *N. c. clarkii* and the freshwater broad-banded water snake (*N. fasciata confluens*), Clay (1938) reduced the salt marsh snakes to subspecies of *N. sipedon*, a name that at the time applied to all of the banded water snakes of eastern North America. Subsequently, Conant (1963) elevated *N. fasciata* to species status to include the three salt marsh snakes and the three southern freshwater subspecies: *N. f. fasciata*, *N. f. confluens*, and *N. f. pictiventris*. At the time that the Atlantic salt marsh snake was listed as threatened, it was regarded as a subspecies of the southern water snake, *N. fasciata* (Conant 1963). More recently, Lawson *et al.* (1991) conducted an extensive electrophoretic analysis of the *N. fasciata*-*N. clarkii* complex, including specimens from three hybrid swarms. They found no genetic introgression between the salt marsh snakes and the adjacent freshwater snakes and concluded that the salt marsh snakes warrant recognition as a separate species, *N. clarkii*. Hence, the appropriate name for the Atlantic salt marsh snake is now *N. c. taeniata*.

At the subspecific level, the Atlantic salt marsh snake has alternately been treated as a separate subspecies or synonymized with the mangrove water snake. It was described by Cope (1895) as *Natrix compressicauda taeniata*, a subspecies of the mangrove water snake. It was synonymized with *N. compressicauda* by Barbour and Noble (1915) but then resurrected as a separate subspecies by Carr and Goin (1942). Dunson (1979) again proposed that *taeniata* should be relegated to synonymy with *compressicauda*. The form that the FWS listed as threatened is the Atlantic salt marsh snake, *Nerodia fasciata taeniata* (now *N. clarkii taeniata*).

The taxonomic status of the Atlantic salt marsh snake will remain controversial until a thorough, rigorous systematic assessment is conducted. The Endangered Species Act (ESA) defines the term species as including “. . . any subspecies of fish or wildlife or plants, and any distinct population or

segment of any species or vertebrate fish or wildlife which interbreeds when mature.” Final resolution of the taxonomic status of the Atlantic salt marsh snake will provide further insight into proper management, but continued protection under the ESA appears justified whether it remains a distinct subspecies or a distinct population. Regardless of its taxonomic status, the Atlantic salt marsh snake is a relict of historical and/or ecological processes unique to Florida and should be preserved (Kochman 1992).

Distribution

The species to which the Atlantic salt marsh snake belongs, *N. clarkii*, is found in a narrow coastal strip from southern Texas, east along the Gulf coast, around the Florida peninsula, and up the east coast of Florida at least as far as the Halifax River, Volusia County. It is also known from the north coast of Cuba (Jaume 1974).

Cope’s (1895) type series and the specimens used by Carr and Goin (1942) to resurrect *N. c. taeniata* came from the brackish coastal marshes of Volusia County, Florida. There is some uncertainty about the precise locality from which Cope’s specimens came, but Carr and Goin (1942) restricted the type locality to the vicinity of National Gardens, which lies near the north end of the Halifax River. Salt marsh snakes have not been documented to the north in southern Flagler County. The Carr and Goin series was collected on the barrier island at New Smyrna Beach.

A problem attendant to the listing of any subspecies that is distributionally continuous and intergradient with another subspecies is the difficulty of defining the limit(s) of the listed form’s distribution in the area where it contacts the related, unlisted subspecies. To the south, the Atlantic salt marsh snake intergrades with the mangrove water snake along the central Atlantic coast of Florida. As mentioned above, both the description and the resurrection of the subspecies were based on specimens from Volusia County, although Carr and Goin (1942) considered a single specimen from Indian River County also to be *N. c. taeniata*. They also mentioned a specimen of salt marsh snake from Melbourne, Brevard County, but did not indicate whether they considered that specimen to be *N. c. taeniata*. Wright and Wright (1957) considered *N. c. taeniata* to extend only as far south as the lower end of Mosquito Lagoon, in northern Brevard County, and Neill (1958) indicated that *N. c. taeniata* intergraded with the mangrove water snake on Merritt Island.

In the final listing of the Atlantic salt marsh snake (FR 42:60743-60745), the FWS indicated that “The Atlantic salt marsh snake is known only from coastal areas of Brevard, Volusia, and Indian River Counties.” However, Hebrard and Lee (1981) examined a large series of salt marsh snakes from southern Mosquito Lagoon near the Volusia-Brevard county line and reported that they “resembled *Nerodia fasciata compressicauda* quite closely.” Hebrard and Lee further noted that their specimens differed markedly in coloration and pattern from specimens of *N. c. taeniata* from further north in Volusia County. It is also worth noting that the snakes examined by Hebrard and Lee were collected in mangroves (species not indicated), whereas only about 10 miles farther north, where populations of typical Atlantic salt marsh snakes are

found, the habitat consists primarily of glasswort (*Salicornia* spp.) flats and salt grass (*Distichlis spicata*)-bordered tidal creeks with only scattered black mangroves (*Avicennia germinans*). The zone of intergradation appears to coincide with the increasing dominance of mangrove swamps; eventually, as mangrove swamps become predominant so does *N. c. compressicauda*. Kochman (1992) concluded that “salt marsh snakes from farther south in Brevard and Indian River Counties, although occasionally striped, appear to comprise a zone of intergradation with *N. c. compressicauda*.” P. Moler (GFC, personal communication 1996) agrees with Kochman.

Until a survey and taxonomic assessment have been conducted, it will not be possible to determine the southern distributional limit of the Atlantic salt marsh snake. We used the distributional map provided during the listing of this subspecies (Figure 1), even though recent information suggests the Atlantic salt marsh snake may be restricted to the brackish, coastal marshes of Volusia County, from the Halifax River south to the northern portions of the Indian River Lagoon (FWS 1993).

Habitat

Atlantic salt marsh snakes are restricted to brackish, tidal marshes. They most often have been found in association with saltwort flats and salt grass-bordered tidal creeks. It is not known if they occur in the adjacent black needlerush (*Juncus roemerianus*) habitat. Atlantic salt marsh snake use of marsh habitats may be limited by water level, with extreme fluctuations making the marsh too hydric or xeric (G. Goode, East Volusia County Mosquito Control, personal communication 1997). When inactive or pursued, they frequently retreat into one of the numerous fiddler crab (*Uca pugilator*) burrows that riddle the edge of the marsh and the banks of the tidal creeks (Carr and Goin 1942, Kochman 1992).

Behavior

Most snakes adapted to life in salt water (families Hydrophiidae, Achrocordidae, and Homalopsidae) possess salt glands, through which they excrete excess salts (Dunson 1975). The salt marsh snakes apparently lack salt glands (Schmidt-Nielsen and Fange 1958), but they nonetheless exhibit very low dehydration rates in seawater (Pettus 1963, Dunson 1978, 1980). Salt marsh snakes are apparently able to survive in seawater through their reduced rates of cutaneous water and salt exchange and their refusal to drink seawater even when they become dehydrated. By contrast, when held in seawater, their freshwater congeners quickly become dehydrated, which prompts them to drink. This merely exacerbates their dehydration and leads to death (Pettus 1963). Salt marsh snakes readily drink fresh water when it becomes available from rain or dew (Kochman 1992).

Although the Atlantic salt marsh snake is most easily observed at night, it may be active at any time of day. Its activity is influenced by tidal cycles, which strongly influence the availability of food (Neill 1958). Although Carr and Goin (1942) indicated that all of their specimens were collected “just as the tide was beginning to overflow the flats,” Kochman (1992) indicated that it

was observed most often “during low tidal stages, when it apparently feeds on small fishes that become trapped in the shallow water.” It feeds primarily on small fish, but it readily takes frogs when available.

Reproduction

This species is ovoviviparous. Captive individuals have given birth to 3 to 9 young from August to October (Kochman 1992). Fecundity is low relative to the adjacent freshwater species, *N. fasciata*, which may give birth to 50 or more young.

Relationship to Other Species

It is well known that salt marsh snakes occasionally hybridize with the closely related freshwater species, especially in areas of habitat disturbance (Kochman 1977, Dunson 1979, Lawson *et al.* 1991). Lawson *et al.* (1991) demonstrated that, despite the reproductive compatibility of the two forms, there appears to be little or no genetic introgression between them in areas of undisturbed habitat. The extent of genetic introgression associated with the local breakdown of reproductive isolation between the two species has not yet been examined.

Status and Trends

The Atlantic salt marsh snake was listed on the basis of two primary concerns: 1) loss of habitat resulting from intensive drainage and development in coastal salt marshes; and 2) the accompanying disruption of reproductive isolating mechanisms, which can lead to hybridization with the Florida banded water snake, and potential swamping of the Atlantic salt marsh snake gene pool by the much larger Florida banded water snake gene pool (FWS 1993).

At the time of its listing, the Atlantic salt marsh snake was thought to include salt marsh snakes as far south as Indian River County (FWS 1977). As suggested above, its distribution may actually be much more restricted, limited to the brackish, coastal marshes of Volusia County. If this is the case, the Atlantic salt marsh snake’s vulnerability to habitat destruction and modification is even greater than previously realized (FWS 1993).

Rising sea levels are not an immediate threat but in the long term may reduce the amount of habitat available to the Atlantic salt marsh snake. As sea levels rise, salinity in the estuaries will also rise correspondingly and possibly change the vegetation of the marsh, eventually flooding the area and making it inhospitable for the snake (FWS 1993).

Historically, Atlantic salt marsh snake habitat probably represented a small portion of the salt marsh and changed periodically from recurring tropical storms. However, with development of Florida’s Atlantic coast, habitat has been permanently lost. This development, coupled with narrow habitat flexibility and a limited range (primarily Volusia County), has resulted in reduced populations of Atlantic salt marsh snakes (FWS 1993).

Recent records for populations identifiable as Atlantic salt marsh snakes are available from the barrier island a short distance north of Ponce Inlet, the mainland shoreline east of the New Smyrna Beach airport, two localities on the

barrier island at New Smyrna Beach, an island in the Indian River east of Edgewater, and from a single specimen identified as *N. c. taeniata* captured just south of the Flagler County line (FWS 1993). It is not known if a viable population exists in this area or to the north in Flagler County.

Destruction of habitat by residential and commercial construction and habitat degradation due to ditching, diking, and water level manipulation have adversely affected *N. c. taeniata* and its habitat. Since little was known of the population size or distribution of Atlantic salt marsh snakes during the period of rapid, unregulated, coastal development of the 1940s through 1960s, it is impossible to quantify habitat loss or direct effects on the *N. c. taeniata* population. However, during review of dredge-and-fill activities from 1983-1992, a minimum of 36 projects were permitted in Volusia County's salt marsh habitat. These projects included dredge-and-fill, shoreline protection projects, construction of piers and marinas, mosquito ditching, and water control structures. However, only 13.2 ha of salt marsh were destroyed by these projects, most (12.2 ha, 18 projects) before 1988. Loss of salt marsh habitat appears to have slowed since 1988 (1.1 acres, 18 projects) indicating improved protection under existing local, State, and Federal conservation policies.

Management

Conservation measures have consisted of limited survey work; genetic comparison with other salt marsh snakes and southern banded water snakes; and creation, restoration, and protection of suitable habitat.

Sporadic surveys conducted from 1978 to 1988 by personnel of the GFC and the FWS confirmed the continued presence of the Atlantic salt marsh snake at several localities in Volusia County. Personnel of the East Volusia County Mosquito Control District are currently conducting surveys for Atlantic salt marsh snakes associated with mosquito control impoundments on islands in the northern portions of the Indian River Lagoon (G. Goode, East Volusia County Mosquito Control District, personal communication 1997). A survey was conducted on Merritt Island NWR in the late 1970s, and a large population of salt marsh snakes was identified in the vicinity of the Volusia-Brevard county line, but this population seemed to show signs of intergradation with the mangrove water snake (Hebrard and Lee 1981).

Localities in the vicinity of New Smyrna Beach were sampled by GFC for genetic studies (Lawson *et al.* 1991). Electrophoretic analyses indicated that the salt marsh snakes are closely related to, but specifically distinct from, the southern banded water snake, and that the three subspecies of the salt marsh snake are electrophoretically indistinguishable from each other (Lawson *et al.* 1991). Tissues were saved for possible comparison of mitochondrial DNA variation in the salt marsh snakes, and that work is underway.

Additionally, to avoid risks of genetic and/or catastrophic events, an attempt should be made to establish self-sustaining populations throughout the subspecies range (FWS 1993). The FWS' recovery plan suggests that self-sustaining populations contain 100 to 200 adult snakes in at least 10 secure, discrete sites dispersed throughout Volusia County. Management of established populations should also include development and implementation of a monitoring program for 5 or more years.

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Recovery for the Atlantic Salt Marsh Snake

Nerodia clarkii taeniata

Recovery Objective: DELIST the species once recovery criteria are met.

South Florida Contribution: DELIST the species once recovery criteria are met.

Recovery Criteria

Because we are still uncertain whether this subspecies occurs in South Florida (Indian River County), we have no more specific delisting criteria than what is outlined in the existing recovery plan for the species.

The Atlantic salt marsh snake can be considered for delisting when there is no evidence of significant genetic introgression (genetic exchange limited to a very narrow hybrid zone) from the Florida banded water snake (*Nerodia fasciata pictiventris*) into adjacent populations of *Nerodia clarkii taeniata*; when habitat is adequately protected and habitat loss is maintained at or below current levels for the next 5 years; and when self-sustaining populations of 100 to 200 adult snakes are established at each of 10 secure, discrete sites dispersed throughout Volusia County (there are no numerical goals for South Florida for this species). These numerical goals are subject to revision as more information becomes available on the biology of the Atlantic salt marsh snake; populations must be monitored for at least 5 years before considering delisting.

Species-level Recovery Actions

- S1. Determine the distribution and status of the Atlantic salt marsh snake in South Florida.**
- S1.1. Conduct surveys of suitable habitat in Indian River County** to determine the extent of suitable habitat that is occupied and the distributional limits of the Atlantic salt marsh snake. These surveys may identify areas of intergradation with the mangrove water snake (*N. c. compressicauda*) and also may identify areas of hybridization with *N. fasciata*. Delineation of the distribution will allow habitat protection efforts to be focused on areas actually occupied by the Atlantic salt marsh snake in South Florida.
 - S1.2. Determine relative abundance within occupied habitats, identify the most important populations and habitat, and develop a population censusing technique.** If populations are identified in the distributional survey, determine relative abundance in different habitats (e.g. *Juncus roemerianus* marsh). This will provide additional direction in identifying habitat protection needs. Populations will need to be monitored to detect population trends. A population indices technique is needed to obtain trend data. Systematic searches of the potholes in the salt flats at low tide to observe snakes or find snake tracks in the mud may be developed into a population index.

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- S2. Protect and enhance existing populations.**
- S2.1. Land acquisition.** Where feasible, identify essential habitats for the Atlantic salt marsh snake and pursue public ownership of these areas through Federal, State, and non-governmental programs.
- S2.2. Enforce regulations.** Use existing regulatory measures such as section 7 of the ESA, section 404 of Clean Water Act and Fish and Wildlife Coordination Act to provide protection to Atlantic salt marsh snakes.
- S3. Conduct research on the biology of the Atlantic salt marsh snake.**
- S3.1. Conduct a taxonomic assessment of the salt marsh snakes in Volusia, Brevard, and Indian River counties.** A taxonomic assessment is required to determine diagnostic criteria to use in evaluating populations identified in the distributional survey. Approaches should include traditional morphometric and meristic analyses and an examination of mitochondrial DNA polymorphisms.
- S3.1.1 Conduct morphometric and meristic analyses.** This subspecies was described at a time when little was known about salt marsh snakes elsewhere on the Atlantic coast. Available diagnoses do not permit an adequate determination of the geographical limits of the taxon. Perform an initial assessment to determine data to be collected from snakes encountered in the distributional survey; thereafter, the survey should proceed concurrently, in order to make additional material available for a taxonomic analysis.
- S3.1.2 Perform analysis of mitochondrial DNA polymorphisms.** This work will further assist in determining the relationship between this form and the mangrove water snake.
- S4. Monitor population(s) of Atlantic salt marsh snakes in habitats where it is found to determine its status and trends.**
- S5. Increase awareness by disseminating information about Atlantic salt marsh snakes.** Although intentional killing is not thought to be a significant factor contributing to the threatened status of this form, an effort should be made to minimize take by informing the public of its protected status.
- S5.1. Produce and distribute educational posters about the identification and protected status of the Atlantic salt marsh snake.** Inform the public about the protected status of the Atlantic salt marsh snake. Posters should be displayed at marinas, bait shops, and schools within the range of the Atlantic salt marsh snake.
- S5.2. Produce and distribute pamphlets to inform landowners about the protected status of the Atlantic salt marsh snake.** Property owners adjacent to Atlantic salt marsh snake habitat should be informed of the potential presence of this snake and its protected status.

Habitat-level Recovery Actions

H1. Prevent degradation of existing habitat.

- H1.1 Identify specific beneficial habitat management practices.** Specific management techniques need to be identified through research and applied to appropriate salt marsh habitats. The effects of open water marsh management (rotary ditching to increase water flow) need to be documented. The applicability of salt marsh restoration activities needs to be evaluated in relation to Atlantic salt marsh snakes. Additionally, burning of mangroves (in areas where mangroves have been killed by freezes) may create additional habitat if the burns revert to the *Salicornia* spp.-*Distichlis spicata* habitat type.
- H1.2. Enforce regulations.** Use existing regulatory measures such as section 7 of the ESA, section 404 of Clean Water Act and Fish and Wildlife Coordination Act to provide protection to salt marsh habitat. Strict application of section 7 (consultation) and 404 regulations within the range of the Atlantic salt marsh snake should reduce loss of existing habitat. Require that mitigation proposals from permitted dredge-and-fill projects obtain conservation easements for protecting existing salt marsh habitat or create and/or restore such habitats.
- H1.3. Monitor water quality for contaminants.** Periodic water quality monitoring in salt marsh habitat should be done to determine possible contamination. Urban runoff, including pesticides and fertilizers applied to lawns, and mosquito spraying, may degrade salt marsh habitats, making them unsuitable for Atlantic salt marsh snakes.

