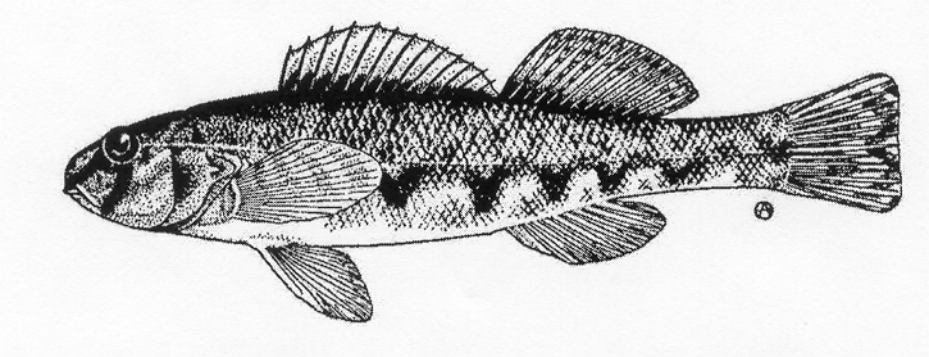
COSEWIC
Assessment and Update Status Report

on the

greenside darter
Etheostoma blennioides

in Canada



NOT AT RISK
2006

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC 2006. COSEWIC assessment and update status report on the greenside darter *Etheostoma blennioides* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 34 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Previous report:

Dalton, Ken. 1990. COSEWIC status report on the greenside darter *Etheostoma blennioides* in Canada. Committee on the status of Endangered Wildlife in Canada. Ottawa. 1-14 pp.

Production note:

COSEWIC would like to acknowledge Alan J. Dextrase for writing the update status report on the greenside darter *Etheostoma blennioides* in Canada, prepared under contract with Environment Canada. COSEWIC gratefully acknowledges the financial support from the Ontario Ministry of Natural Resources (OMNR). The report was overseen and edited by Dr. Robert Campbell, Co-chair of the COSEWIC Freshwater Fishes Species Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-953-3215
Fax: 819-994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le dart vert *Etheostoma blennioides* au Canada – Mise à jour.

Cover illustration:
Male greenside darter — drawing by Anker Odum reproduced from Scott and Crossman 1973 with permission of W.B. Scott.

Catalogue No. CW69-14/511-2007E-PDF
ISBN 978-0-662-45968-2

Recycled paper

COSEWIC
Assessment Summary

Assessment Summary – November 2006

Common name
Greenside Darter

Scientific name
Etheostoma blennioides

Status
Not at Risk

Reason for designation
Recent surveys have shown that the species is widespread and abundant in the Ausable, Sydenham and Thames rivers as well as Lake St. Clair. The total Canadian population has also increased through the recent colonization of the Bayfield River, Big Otter Creek, Detroit River and Grand River. Rescue of greenside darter populations in Canada is possible from Michigan populations.

Occurrence
Ontario

Status history
Designated Special Concern in April 1990. Status re-examined and designated Not at Risk in November 2006. Last assessment based on an update status report.

COSEWIC
Executive Summary

greenside darter
Etheostoma blennioides

Species information

The greenside darter is one of seven members of the genus *Etheostoma* found in Canada. It is the largest member of the genus, reaching lengths of up to 170 mm, but the average length in Canada is 76 mm. The greenside darter can be distinguished from other members of the genus in Canada by its green colouration, the fusion of the upper lip to the side of the head, and the presence of large V-shaped marks on the side of the body.

Distribution

The greenside darter occurs in drainages of the lower Great Lakes and the Mississippi River from New York and Maryland west to eastern Kansas and Oklahoma, and from Ontario south to Georgia, Alabama and Arkansas. The species is also found in the Mohawk, Susquehanna and Potomac River drainages of the Atlantic Slope from New York south to Virginia. It is only known in Canada from southwestern Ontario where it occurs in tributaries to Lake Huron, Lake St. Clair, and Lake Erie. Since the status of this species was last reviewed in 1990, the greenside darter has been found to be extant at most historical locations (within four river systems and Lake St. Clair) and has appeared to have expanded its range in the Ausable and Sydenham rivers. It has also been found in five new watersheds as a result of range expansion.

Habitat

The greenside darter is widely distributed in a variety of habitats, but is primarily found in creeks and small to medium rivers with abundant gravel and rubble riffles. It is often associated with vegetation, particularly filamentous green algae in the genus *Cladophora*.

It also inhabits the shorelines of some large lakes such as Lake St. Clair in Ontario and the Ohio waters of Lake Erie. Greenside darter normally spawn in swift, rubble-covered riffles where larger rocks are covered with growths of the filamentous algae *Cladophora* spp., or the moss *Fontinalis* spp. Although urban development and agricultural activities have impacted aquatic habitats and have probably contributed to the decline of other aquatic species at risk in watersheds containing greenside darter,

populations have appeared to remain stable or have expanded their range in the face of these changes. The colonization of five new watersheds by the greenside darter over the last 15 years has resulted in an increase in available habitat.

Biology

The greenside darter is relatively short-lived, having a typical life span of 3 years. Individuals of both sexes mature in the spring following their first growing season at age 1. Greenside darter spawn in the spring when water temperatures reach 10.6^{o}C. Spawning occurs in March and April in the southern part of their range, while in the north, spawning is initiated in April and can continue into June. The adhesive eggs are normally laid on filamentous algae, or on an aquatic moss close to the point of attachment to the rock. Eggs hatch in 18-20 days at 13-15^{o}C and larvae transform into the juvenile stage in late June and July. Greenside darter are benthic (bottom dwelling) insectivores that feed primarily on the larvae of midges (Chironomidae), blackflies (Simuliidae) and mayflies (Ephemeroptera). A broad range of food items has been reported, suggesting that the greenside darter is an opportunistic feeder. The greenside darter is less tolerant of high water temperatures and low summer oxygen levels than other darters with which they commonly co-occur. The rapid spread of greenside darter within the Potomac River in the United States and within the Grand River in Ontario provides evidence of its dispersal abilities.

Population sizes and trends

Recent surveys have shown that the greenside darter is widespread and abundant in the Ausable, Sydenham and Thames rivers. Sampling in Lake St. Clair in the 1990s has revealed their widespread presence in the lake and perhaps an increase in abundance. The greenside darter was introduced to the Grand River watershed prior to 1990 and, in 15 years, has become established in more than 200 stream km where it is often abundant. There is no information on the abundance of greenside darter in the Bayfield River, Big Creek, Big Otter Creek, Detroit River or Pefferlaw Brook. Rescue of greenside darter populations in Canada is possible from Michigan populations.

Limiting factors and threats

There are several potential threats to greenside darter populations in Canada, but none appear to be imminent or currently having a significant impact on populations. Potential threats include: impoundments; sediment and nutrient inputs associated with agricultural activities; contaminants associated with industrial activity and agricultural runoff; rapid urban growth in the Grand and Thames river watersheds; and predation and competition from the introduced round goby (*Neogobius melanostomus*).

Special significance of the species

The greenside darter likely plays an important role in converting benthic energy in lotic ecosystems. It also serves as a larval host for one endangered mussel species in

Canada. The greenside darter is of considerable interest for scientific studies and may be of interest as an aquarium fish.

Existing protection and other status designations

Assessed by COSEWIC in 1990 as special concern, the greenside darter is not protected by any federal or provincial species at risk legislation in Canada. The greenside darter is considered globally secure (G5), and is ranked as secure (S4 or S5) in most American states where it occurs.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

Update
COSEWIC Status Report

on the

greenside darter
Etheostoma blennioides

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2006

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SPECIES INFORMATION

Name and classification

Class:	Actinopterygii
Order:	Perciformes
Family:	Percidae
Genus:	*Etheostoma*
Subgenus:	*Etheostoma*
Species*:	*Etheostoma blennioides* Rafinesque, 1819
Common name:	English* greenside darter
	French† dard vert

*from Nelson *et al.* (2004)
† from Scott and Crossman (1973)

Four subspecies of greenside darter have been described (Miller 1968). One of these subspecies, *Etheostoma blennioides gutselli*, which occurs in the Little Tennessee River and Pigeon River systems of eastern Tennessee, was recently elevated to the species level as the Tuckasegee darter (*Etheostoma gutselli*) (Nelson *et al.* 2004). Of the three remaining subspecies, only *Etheostoma blennioides pholidotum* occurs in Canada (Miller 1968).

Morphological description

Etheostoma is the largest and most diverse genus of North American fishes with 131 species currently recognized (Nelson *et al.* 2004). There are seven species of *Etheostoma* found in Canada, and the greenside darter is the only one of these that belongs to the subgenus *Etheostoma*. This subgenus is characterized by eyes set high on a broad head with a short rounded snout, heavy lips, broadly joined gill membranes, large rounded pectoral fins, complete supratemporal and infraorbital sensory canals and males with a predominantly green body colouration (Kuehne and Barbour 1983).

The greenside darter is the largest member of the genus *Etheostoma*, reaching lengths of up to 170 mm (Page and Burr 1991), although most Canadian specimens recorded are less than 110 mm long and the average total length is 76 mm (Scott and Crossman 1973). The greenside darter has a robust body form with a blunt, rounded snout (Fig. 1). The snout sometimes slightly overhangs the small mouth. Although there is no premaxillary frenum in *E. blennioides pholidotum* (Page 1983), the premaxillaries are not protractile because the anterior half of the maxillaries are fused to the suborbitals by flesh and skin (Scott and Crossman 1973; Trautman 1981). A symphyseal knob may be present on the upper lip. The gill membranes are broadly joined and are free from the isthmus. The greenside darter has a complete lateral line with 50-86 scales (53-68 scales in *E. blennioides pholidotum*) and, like other species in the genus, lacks a swim bladder (Kuehne and Barbour 1983). The spiny and soft dorsal fins are close together and consist of 12-14 spines and 12-14 rays, respectively. The anal fin consists of 2 spines, 7-9 rays, and originates below the origin of the soft dorsal fin (Miller 1968; Scott and Crossman 1973). The paired fins, anal fin, and spiny dorsal fin are usually larger on males than on females. The barred caudal fin has a shallow

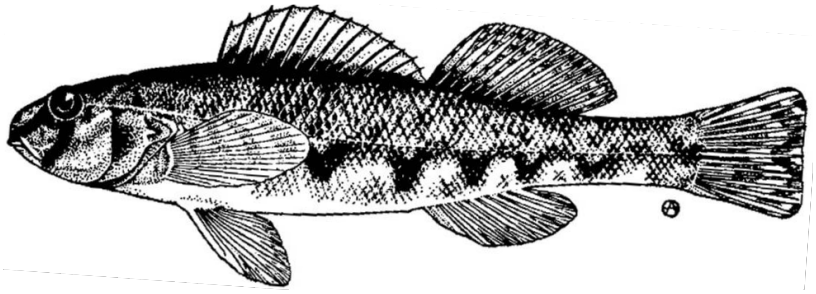

Figure 1. Male greenside darter, *Etheostoma blennioides* (drawing by Anker Odum reproduced from Scott and Crossman 1973 with permission of W.B. Scott).

fork. The cheek, opercle and belly are fully scaled. Spawning males develop tubercles on the posterior half of the ventral surface of the body (Smith 1985). Spawning females develop elongate urogenital papillae (Winn 1958a).

The greenside darter is one of Canada's most colourful freshwater fishes (Fig. 2). The overall colouration is olive-green dorsally, with pale green to yellow-green on the sides and pectoral, anal and caudal fins (Scott and Crossman 1973; Jenkins and Burkhead 1994). The green colouration is intensified in breeding males sometimes to the extent that other markings cannot be detected. The dorsal fins are often red at their base and are green in males. The belly is creamy white. The upper side (above the lateral line) is flecked with reddish brown spots. There are 5-8 square, brownish-green saddles on the back that do not extend far down the side and are often obscured in larger, more colourful fish. Laterally, there are 5-10 large olive-brown V-shaped marks (may also appear as blotches, bars, Us or Ws) that extend below the lateral line (Scott and Crossman 1973; Trautman 1981; Kuehne and Barbour 1983). These lateral markings can also be obscured in intensely coloured breeding males which develop a brilliant green colour with 4-7 dark green vertical bands on the posterior half of the body (Trautman 1981). Females tend to be predominantly yellow to greenish yellow (Smith 1985). Both sexes turn a more intense green colour when water temperature cools in the fall and this colour remains until spawning is complete in the spring (Fahy 1954; Smith 1979).

The fusion of the upper lip to the side of the snout is unique and readily separates the greenside darter from all other Canadian darters. The green colour and the lateral V-shaped markings are also distinctive. Although juveniles often lack the green colouration, both the fused upper lip and the lateral markings can be used to distinguish them from other species. Very small greenside darter are often mistaken for johnny darter (*Etheostoma nigrum*), which have a similar colour and body form (Trautman 1981). Baker (1979) provides a detailed description of greenside darter larval development.

Figure 2. Male greenside darter, *Etheostoma blennioides*, from Conestogo River of the Grand River drainage captured in July 2002 (photo: Jason Barnucz, Fisheries and Oceans Canada, Burlington, Ontario).

Genetic description

There have been no genetic studies completed on Canadian populations of greenside darter, although work has been initiated at the University of Windsor (N.E. Mandrak, pers. comm. 2005). It is likely that gene flow between, and perhaps within, some Canadian watersheds is limited, but this has not been investigated. Gene flow between populations in parts of the American range has been examined using allozyme electrophoresis. Heithaus and Laushman (1997) found that genetic variation was high within greenside darter populations in Ohio streams, and that gene flow between populations was not significant. Lower genetic variation was found in the polluted Huron River system. Conversely, Faber and White (2000) found high gene flow among greenside darter populations in two Ohio River tributaries. Turner and Trexler (1998) found greater gene flow between greenside darter populations within the Ohio River region, and within the Ouachita Region (Missouri and Oklahoma), than within the Ozark region (Missouri and Arkansas). A phylogenetic analysis of 26 darter species using allozyme electrophoresis confirmed the placement of the greenside darter in the subgenus *Etheostoma* (Wood and Mayden 1997).

Designatable units

All Canadian populations are found within the Great Lakes-Western St. Lawrence Freshwater Ecological Area. There are no known distinctions between the populations within this area that warrant consideration of designatable units below the species level.

DISTRIBUTION

Global range

The greenside darter occurs in drainages of the lower Great Lakes (southern Lake Huron, Lake Erie and southern Lake Ontario) and the Mississippi River from New York and Maryland west to eastern Kansas and Oklahoma, and from Ontario south to Georgia, Alabama and Arkansas (Lee *et al.* 1980, Page and Burr 1991) (Fig. 3). The species is also found in the Mohawk, Susquehanna and Potomac River drainages of the Atlantic Slope from New York south to Virginia. There is a hiatus in the southern portion of the range, with a disjunct segment occurring in Kansas, Missouri, Arkansas and Oklahoma. Although Schwartz (1965) considered the Potomac River to be part of the native distribution of the greenside darter, Jenkins and Burkhead (1994) concluded that it was introduced given its relatively recent discovery (late 1950s) and ongoing range expansion within this watershed. Its presence in the Susquehanna River drainage (where it was first recorded in 1962) is believed to be the result of stream capture from the Allegheney River drainage (Denoncourt *et al.* 1977). The greenside darter occurred historically in 19 states, the District of Columbia and Ontario (NatureServe 2006). It has been extirpated from several American streams, but its overall range has not changed significantly. The species is ranked as SH (historic – no verified records within the last 20 years) in the District of Columbia (NatureServe 2006).

Canadian range

The greenside darter is only known in Canada from southwestern Ontario where it occurs in tributaries to Lake Huron, Lake St. Clair and Lake Erie (Fig. 4). The Canadian distribution represents less than 5% of the global range of the greenside darter. When the status of the greenside darter was initially assessed by COSEWIC in 1990, it was known from the Ausable River (southern Lake Huron drainage), Sydenham River, Thames River, Lake St. Clair (Lake St. Clair drainage) and Big Creek (Lake Erie drainage) (Dalton 1991). Dalton (1991) mistakenly mapped a 1975 record from Gold Creek as being near the city of Sarnia at the southern tip of Lake Huron. The Gold Creek in question is actually in the Sydenham River watershed in the vicinity of the town of Strathroy. Since the status of the species was last assessed 1990, its presence has been confirmed in all of the Canadian watersheds, and at most locations where it was captured historically (Fig. 4). The range of the greenside darter within the Ausable River and the Sydenham River appears to have expanded since 1990. This is likely a combination of increased sampling effort (particularly in smaller tributaries) as well as actual range expansion.

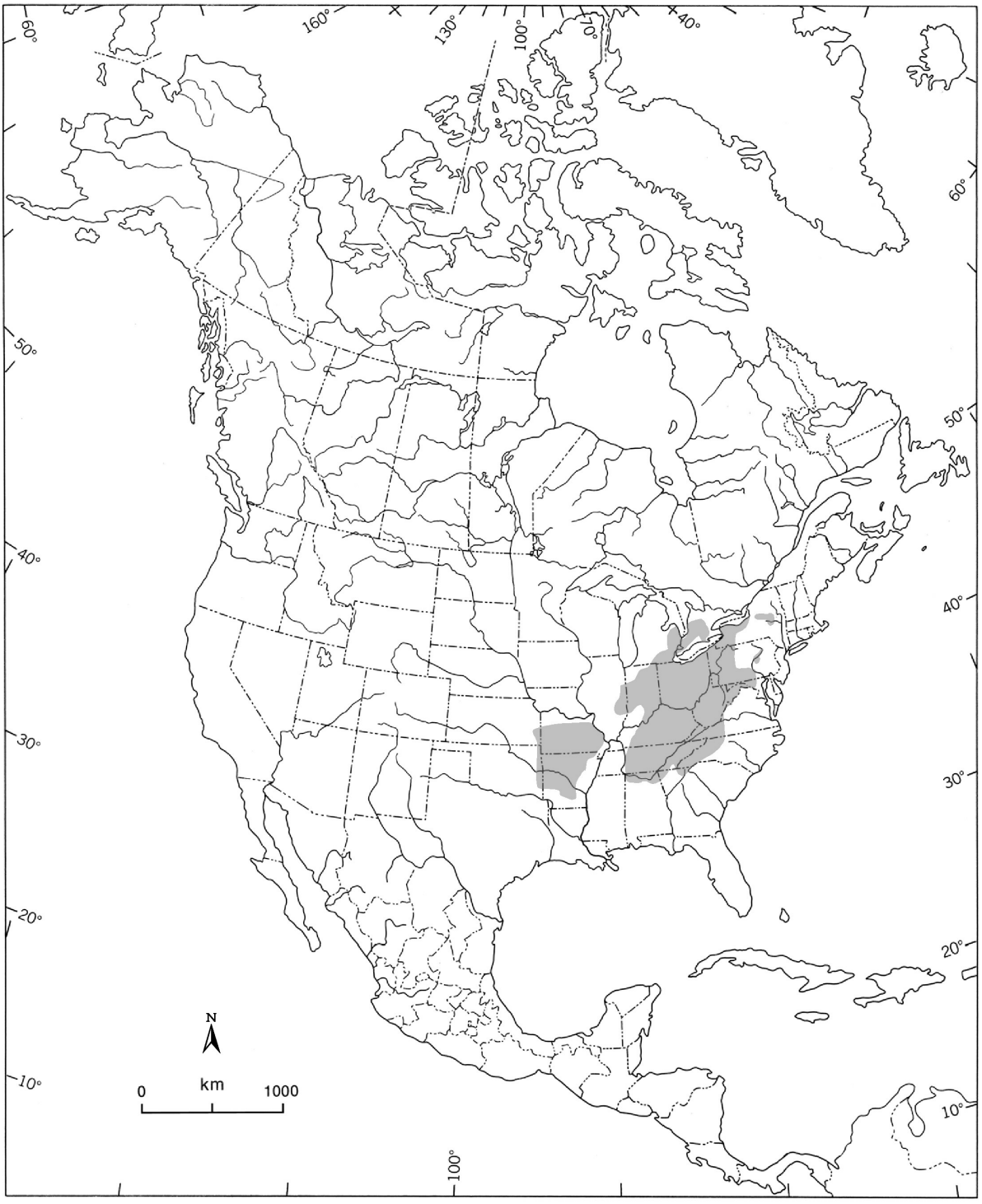

Figure 3. Global range of the greenside darter, *Etheostoma blennioides*.

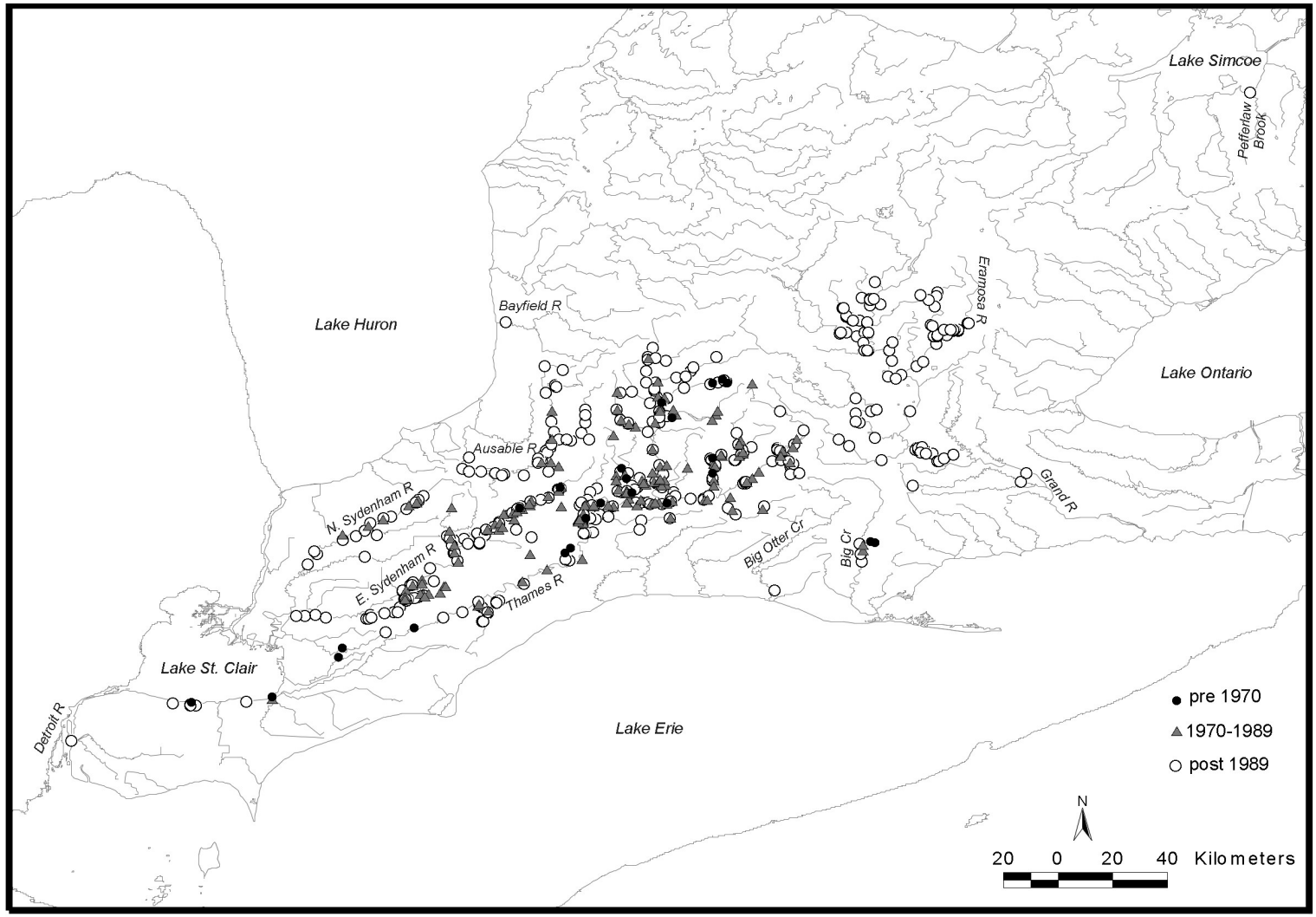

Figure 4. Canadian range of the greenside darter, *Etheostoma blennioides*.

The greenside darter has been reported in five new watersheds since its status was last assessed in 1990. The greenside darter was collected from the Grand River watershed of the Lake Erie drainage for the first time, and it has since colonized much of this watershed (Fig. 5). Evidence strongly suggests that this is an introduced population (see Population sizes and trends below). In 1998, four juvenile greenside darter (43-46 mm) were reported from a single site on Big Otter Creek (Lake Erie drainage). Although there are no voucher specimens to confirm this record, the sampling crew was knowledgeable and was familiar with the species (S. Gibson, pers. comm. 2005). Intensive sampling at numerous sites in Big Otter Creek during 2002 and 2003 (D. Depasquale, pers. comm. 2005), and sampling by the author at three different sites in the vicinity of the 1998 collection in fall 2004, did not capture any greenside darter. In 2002, two greenside darter were collected from the Bayfield River by DFO, and one was deposited in the Royal Ontario Museum (ROM 75857). It is possible that the individual greenside darter in these two systems may have naturally dispersed from adjacent river systems (Big Creek and Ausable River respectively). The greenside darter was found in the Canadian waters of the Detroit River (Ruwe Marsh) for the first time in 1995 (Tulen *et al.* 1998). Significant sampling effort in the Canadian waters of the Detroit River in 2003 and 2004 did not capture any greenside darter (Lapointe 2005, N.E. Mandrak, unpubl. data). It is possible that the species was always present, but not detected, or that it dispersed from the American waters of the Detroit River or downstream from Lake St. Clair. In the fall of 2005, several greenside darter were captured in Pefferlaw Brook of the Lake Simcoe drainage (J. Barnucz, pers. comm. 2005), during surveys conducted prior to treatment with rotenone to eradicate a population of introduced round goby (*Neogobius melanostomus*). The round goby was presumed to be introduced via a baitfish holding pond adjacent to the stream, and it is likely that greenside darter was introduced to this stream via the same mechanism. This location is more than 100 km northeast of the closest greenside darter population in the Grand River. Given its distinctive appearance, it is highly unlikely that the greenside darter would have been misidentified in earlier collections in these five watersheds. Further sampling is required to determine if populations are established in these watersheds, and if they are more widespread. It is quite possible that the Pefferlaw Brook population was extirpated by the 2005 rotenone treatment. A survey conducted in 2006 did not collect any greenside darter (N. Mandrak, pers. comm. 2006).

The extent of occurrence of the greenside darter in Canada is approximately 38,400 km^2. The current area of occupancy is estimated to be 33 km^2 (both area values estimated from Fig. 4). It is difficult to determine the number of locations for the greenside darter in Canada. The species has been captured at hundreds of sites in at least ten tertiary watersheds. The Natural Heritage Information Centre recognizes 76 extant and historical element occurrences within these watersheds (NHIC 2005).

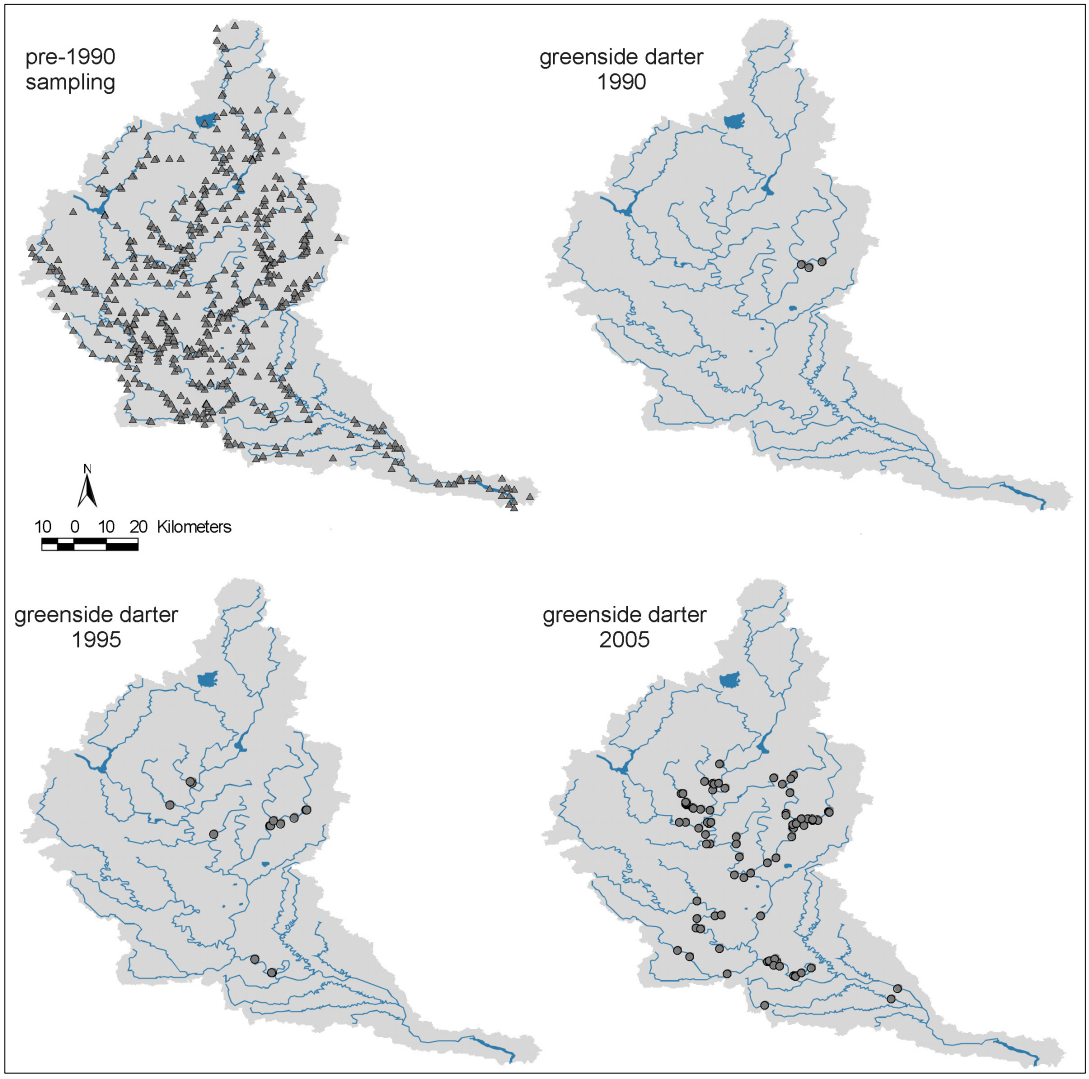

Figure 5. Spread of the greenside darter, *Etheostoma blennioides*, in the Grand River watershed between 1990 and 2005. Upper left map shows fish sampling effort in the watershed prior to the first discovery of greenside darter in 1990.

HABITAT

Habitat requirements

The greenside darter is widely distributed in a variety of habitats, but is primarily found in creeks and small to medium rivers with abundant gravel and rubble riffles (Kuehne and Barbour 1983; Page and Burr 1991). It is usually found in the moderate to fast moving water within these riffles (Smith 1979; Lee *et al.* 1980), and is often associated with vegetation, particularly filamentous green algae in the genus *Cladophora* (Fahy 1954; Kuehne and Barbour 1983; McCormick and Aspinwall 1983; Page 1983; Bunt *et al.* 1998). The greenside darter typically inhabits clear streams

(Jenkins and Burkhead 1994; Lee *et al.* 1980), but also appears to thrive in some turbid systems such as the Ausable River, Sydenham River and Thames River in Canada. Poos (2004) found that greenside darter within the Sydenham River inhabited areas with lower turbidity levels. Habitats of rocky substrate highly embedded with fine materials (silt and sand) do not appear to be suitable for greenside darter (Bunt *et al.* 1998; Stewart and Veliz 2004). Coker *et al.* (2001) classified the greenside darter as a cool/warmwater species. The greenside darter is absent in shallow headwater habitats in Ohio, especially during the warm summer months, perhaps due to its thermal tolerances (Hlohowskyj and Wissing 1985).

The greenside darter is not restricted to riffle areas of streams although it is most commonly found in these habitats. It also inhabits the shorelines of some large lakes, such as Lake St. Clair in Ontario, and the Ohio waters of Lake Erie, where it occurs around the islands in the western basin and along vegetated habitats on the south shore of the lake (Van Meter and Trautman 1970). Bunt *et al.* (1998) did not find any greenside darter in the impounded lentic habitat upstream of the Mannheim Weir in the Grand River, Ontario. However, greenside darter have been captured in Guelph Lake, a large impoundment in the same drainage (Reid 2004). The greenside darter is often observed foraging over boulders or submerged logs in pools having little current (Pflieger 1975).

Several authors have investigated microhabitat use by the greenside darter and co-occurring species in stream habitats. Although there are differences between ecosystems, greenside darter tend to prefer larger substrate in riffles than conspecifics (Englert and Seghers 1983; Hlohowskyj and Wissing 1986; Welsh and Perry 1998). Bunt *et al.* (1998) found greenside darter in the Grand River, Ontario were primarily located on unembedded large cobble and boulder substrate covered with *Cladophora* spp. Poos (2004) found greenside darter in the Sydenham River in habitats with a high percentage of cobble substrates. Hlohowskyj and Wissing (1986) suggested that the preference for large substrates may be related to their suitability as attachment sites for epilithic algae. The greenside darter also appears to prefer deeper areas of riffle habitats (Fahy 1954; Hlohowskyj and Wissing 1986; Chipps *et al.* 1993; Stauffer *et al.* 1996; Grossman and Ratajczak 1998).

Seasonal and age-based differences in microhabitat use can occur in some streams. Grossman and Freeman (1987) found no size-related differences in microhabitat use by greenside darter in a North Carolina stream. In Salmon Creek, New York, Fahy (1954) found that all age-groups of both sexes can be found in riffles throughout the year, but in late fall and winter, juveniles and age I females were also found in quiet water. Schwartz (1965) also stated that greenside darter move into pools during the fall and winter months. Young-of-the-year greenside darter have been reported to use areas with reduced current compared to adults (Pflieger 1975; Smith 1985; Greenberg and Stiles 1993).

Greenside darter normally spawn in swift, rubble-covered riffles where larger rocks are covered with growths of the filamentous algae *Cladophora* spp. or the moss

Fontinalis spp. (Winn 1958a). Eggs are laid directly on the vegetation. Egg deposition has also been reported on milfoil (*Myriophyllum* sp.) on one occasion (Winn 1958b). Schwartz (1965) reported spawning over fine sand downstream of boulders, and this may also occur in Virginia where the greenside darter is often not associated with vegetation (Jenkins and Burkhead 1994).

Newly hatched larvae probably drift downstream to pools and quiet backwaters immediately downstream of spawning areas. Fahy (1954) did not find larvae on the algae where they hatched, and Baker (1979) captured large numbers of greenside darter larvae in a pool immediately downstream of a spawning riffle.

Habitat trends

Although urban development and agricultural activities have impacted aquatic habitats and have probably contributed to the decline of other aquatic species at risk (fishes and mussels) in the Ausable River, Big Creek, Grand River, Sydenham River, and Thames River watersheds (Nelson *et al.* 2003; Staton *et al.* 2003; Portt *et al.* 2004; Taylor *et al.* 2004), populations of greenside darter appear to have remained stable or have expanded their range in the face of these changes. All of these watersheds are primarily agricultural, and the Grand River and Thames River have large and growing urban populations. Excessive nutrient enrichment and sedimentation have been identified as problems in most of these watersheds. However, the high nutrient input from agricultural activities may encourage luxuriant growths of filamentous algae that are used as spawning habitat by the greenside darter. All of these watersheds have impoundments, and are subject to extensive agricultural drainage (open and tile drains). The hydrology of the Ausable River has been particularly affected by channel realignments (Nelson *et al.* 2003). Stewardship and other recovery actions to improve watershed health are ongoing in the Ausable, Grand, Sydenham, and Thames River watersheds as part of watershed-based ecosystem recovery plans for these systems. Habitat in Lake St. Clair changed dramatically after the invasion of zebra mussels (*Dreissena polymorpha*) in the late 1980s when water clarity and the abundance of aquatic macrophytes increased significantly (Griffiths 1993). These changes associated with the zebra mussel invasion may have improved habitat for greenside darter in the lake. Although there is extensive habitat available for greenside darter in the Detroit River, much of this habitat is degraded or at risk due to historical and current industrial and agricultural activity, as well as urban development (Environment Canada 2003). Remedial Action Plans are currently being implemented for the Detroit River by Canada and the United States as part of the Great Lakes Area of Concern program.

The colonization of five new watersheds by the greenside darter over the last 15 years has resulted in an increase in available habitat. This is particularly true in the Grand River, where the greenside darter now occurs throughout a large portion of the main stem of the river and has colonized 10 tributaries.

Habitat protection/ownership

The habitat of the greenside darter is subject to the general habitat protection provisions of the federal *Fisheries Act*. Adjacent lands receive policy-level protection through the fish habitat provisions of the Provincial Policy Statement (PPS) under the provincial *Planning Act*. The PPS prohibits development or site alteration on adjacent lands (within 30 m of fish habitat) unless it can be shown through an Environmental Impact Study that the fish habitat in question will not be negatively impacted. Recent amendments to the *Planning Act* now require municipal planning decisions to be consistent with the PPS. The provincial *Lakes and Rivers Improvement Act* may also indirectly protect greenside darter habitat when applications for the construction or maintenance of dams and dredging activities are reviewed. Aspects of the provincial *Nutrient Management Act*, *Environmental Protection Act*, *Water Resources Act*, and *Source Water Protection Act* may also provide indirect protection for greenside darter habitat. As a special concern species, there is no federal or provincial species at risk legislation that provides direct habitat protection specifically for the greenside darter.

The beds of the rivers inhabited by the greenside darter are largely owned by the Crown, but the majority of adjacent lands are privately owned and in agricultural production. On the Grand River and Thames River, there are significant portions of adjacent lands in urban areas. The Detroit River population occurs downstream of the large metropolitan area of the cities of Detroit and Windsor. Less than 5% of adjacent lands are in protected areas. Greenside darter habitat or potential habitat occurs within the territories of five First Nations: Six Nations of the Grand River (Grand River); Chippewas of the Thames First Nation, Munsee-Delaware Nation, and Oneida First Nation (Thames River); and Walpole Island First Nation (Lake St. Clair).

BIOLOGY

As a widespread and relatively common species in eastern North America, the biology of the greenside darter has received considerable attention. This includes studies specifically examining the life history of the greenside darter as well as ecological studies on stream fish communities. Most of this research has been conducted in the United States, but there are some Canadian studies.

Life cycle and reproduction

The greenside darter is relatively short-lived, reaching a maximum age of 5 years. The typical lifespan for the population in Salmon Creek, New York, studied by Fahy (1954), was 3 years. Collections in the fall and winter had roughly equal numbers of young-of-the-year, one- and two-year-olds. There were fewer three-year-olds and only one four-year-old. In this system, there appeared to be high mortality after spawning between the third and fourth growing season (Fahy 1954). The maximum age for males was 4 years, and the oldest females were 5 years of age. Bunt *et al.* (1998) found a maximum age of 3 years for greenside darter in the Grand River, Ontario. Reported

greenside darter sex ratios (female:male) are 1:1 for Salmon Creek, NY (Fahy 1954), 1.1:1 for 38 collections compiled by Carlander (1977) and 1.4:1 for the Grand River, ON (Bunt *et al.* 1998). Sex ratios may vary with time of year and habitat sampled.

Greenside darter grow quickly and achieve 60% of their total growth during their first year (Fahy 1954). Individuals of both sexes mature in the spring following their first growing season at age 1 (Fahy 1954; Bunt *et al.* 1998). Males grow faster than females and reach a larger size than females (Fahy 1954; Bunt *et al.* 1998). Given that fish mature at age 1 and that few live beyond age 3, generation time is estimated at 2 years. It appears that the greenside darter spawns each year.

The fecundity of greenside darter reported in the literature ranges from 181-1832 eggs/female (Fahy 1954; Winn 1958a; Kellogg *et al.* 1997; Bunt *et al.* 1998). Total length is more important than age in determining fecundity. Bunt *et al.* (1998) found that the fecundity of greenside darter in the Grand River was significantly lower than for the American population studied by Winn (1958a), and suggested that the longer and colder winters in southern Ontario might limit the energy available for the production of eggs. Kellogg *et al.* (1997) found significant variation in the fecundity of three different greenside darter populations within the Allegheny River drainage of Pennsylvania. Differences between populations may have been related to fish densities, number of competing species, and the presence of elevated heavy metal levels in one of the systems.

Greenside darter spawn in the spring when water temperatures reach 10.6^{o}C (Fahy 1954). If spawning is initiated and the water temperature drops below this critical temperature or if the water becomes excessively turbid after a heavy rainfall, egg-laying activity may slow or cease (Fahy 1954; Winn 1958a). Trautman (1981) stated that most spawning activity in Ohio occurs when water temperatures are below 18^{o}C and Baker (1979) reported spawning activity in Tennessee at water temperatures between 10.2 and 19.0^{o}C. Greenside darter spawn in March and April in the southern part of their range (Pflieger 1975; Winn 1958a), while in the northern part of their range, spawning is initiated in April and can continue into June (Fahy 1954; Winn 1958a). Fahy (1954) found that the spawning period in New York coincided with the period of maximum coverage of riffles by filamentous algae. It is likely that the spawning period for Canadian populations extends from mid-April to mid-June similar to populations in New York and Michigan.

Eggs are normally laid on filamentous algae (*Cladophora* spp.) or on an aquatic moss (*Fontinalis* spp.) (Fahy 1954; Winn 1958b; Trautman 1981; Kuehne and Barbour 1983), although this does not appear to be a requirement (Schwartz 1965; Jenkins and Burkhead 1994). Both males and females spawn with several different individuals (Fahy 1954; Page 1983). Males select territories, and are stimulated by swimming movements and nudging by the female (Fahy 1954; Winn 1958b). The male then mounts the female on an angle and fertilizes the eggs which are laid on the vegetation close to the point of attachment to the rock (Fahy 1954; Winn 1958b). The eggs are demersal and adhesive, and average 1.8 mm in diameter (Fahy 1954; Winn 1958a).

The spawning period is protracted as females lay several batches of eggs that mature in succession. Females lay their entire complement of eggs over 10-12 occasions over 4-5 weeks (Fahy 1954). In laboratory observations, Fahy (1954) found that greenside darters spawned at night, while Winn (1958b) observed spawning activity only in the early morning and throughout the day. Hybrids with the dusky darter (*Percina sciera*) and logperch (*P. caprodes*) have been reported in Ohio (Trautman 1981), but there are no records of greenside darter hybrids from Canada (E. Holm, pers. comm. 2005).

There is no direct parental care of eggs, but males defend spawning territories providing indirect protection (Winn 1958a). Territories are 80-100 cm in diameter and are centred on a large rock with attached algae. The presence of other males was needed before territories were established, and Fahy (1954) found that no such territories were established in his observations. This suggests that territorial behaviour may be modified by environmental and social conditions (Winn 1958b). Winn (1958a) observed that individuals were scattered (30 cm-200 cm from nearest neighbours) in riffle habitats during the summer and fall, which also suggested a form of territoriality.

Eggs hatch in 18-20 days at 13-15^{o}C, and newly hatched larvae are 6.8-7.5 mm long (Fahy 1954; Winn 1958a). The larvae develop to a length of about 20 mm after which they transform into the juvenile stage (Baker 1979). Fahy (1954) estimated that transformation into juveniles occurred in late June and July in Salmon Creek, NY. The juvenile stage is relatively short-lived as all fish mature the spring following hatching.

Feeding/Nutrition

The subterminal mouth of the greenside darter is adapted for feeding on top of rocks (Page and Swofford 1984; Kessler *et al.* 1995). The small mouth size may restrict it to smaller food sizes (1-4 mm) than other darter species, even though it is the largest member of the genus *Etheostoma* (van Snik Gray *et al.* 1997). Greenside darter feed throughout the year, but feeding activity is lowest during the winter months (Fahy 1954).

Greenside darter are benthic insectivores that feed primarily on the larvae of midges (Chironomidae), blackflies (Simuliidae) and mayflies (Ephemeroptera). Several studies have shown that midge larvae are the most important food item for adult fish (Turner 1921; Wynes and Wissing 1982; Hlohowskyj and White 1983; van Snik Gray *et al.* 1997). In the Grand River (Ontario) mayflies and caddisflies (Trichoptera) were the most abundant summer foods followed by midges and blackflies. Young fish feed on cladocerans and copepods (Crustacea) in addition to smaller insect prey (Turner 1921). Fahy (1954) found that greenside darter obtained food according to its availability in a New York stream, but Hlohowskyj and White (1983) found positive selection for blackfly and midge larvae. The following broad range of food items has been reported as a smaller portion of the diet, suggesting that the greenside darter is an opportunistic feeder: insects – stoneflies (Plecoptera), craneflies (Tipulidae), aquatic caterpillars (Lepidoptera), beetles (Coleoptera), true bugs (Hemiptera); molluscs – snails and limpets (Gastropoda); crustaceans – ostracods (Ostracoda), scuds (Amphipoda); arachnids – water mites (Hydracarina); annelids – oligochaetes

(Oligochaeta), leeches (Hirudinea); and, fish eggs and fish remains (Turner 1921; Hlohowskyj and White 1983; Etnier and Starnes 1993; van Snik Gray *et al.* 1997; Bunt *et al.* 1998).

Predation

Several potential predators of greenside darter have been identified, but actual predation has rarely been recorded. Bunt *et al.* (1998) identified small greenside darter in the gut contents of several stonecat (*Noturus flavus*). Cooper (1983) suggested that the greenside darter was probably an important forage fish for rock bass (*Ambloplites rupestris*) and smallmouth bass (*Micropterus dolomieu*) in Pennsylvania streams. Northern watersnake (*Nerodia sipedon*), snapping turtle (*Chelydra serpentina*) and piscivorous birds were identified as possible predators in New York (Fahy 1954). In laboratory studies, other fishes ate greenside darter eggs and greenside darter parents ate their own eggs when they were laid on non-plant substrates (Winn 1958b). Fahy (1954) found evidence of egg predation in a New York stream, but was unable to identify the predator. The greenside darter may be more vulnerable to predation than other darters as they often rest on top of rocks. However, predation has not been linked to declines or identified as a threat in greenside darter populations.

Laboratory studies have demonstrated that greenside darter may use different predator avoidance tactics. Greenside darter showed a greater avoidance distance in response to a splashing stimulus than other darters (Englert and Seghers 1983). Radabaugh (1989) found that breeding and non-breeding greenside darter tended to freeze in response to a simulated predator, relying on camouflage to escape detection.

Physiology

Greenside darter are less tolerant of high water temperatures than the fantail darter (*Etheostoma flabellare*) and rainbow darter (*E. caeruleum*) with which they commonly co-occur (Holohowskyj and Wissing 1985). Critical thermal maxima for greenside darter from two Ohio streams were 25.8^{o}C in the winter and 35.1^{o}C in the summer. Comparable values for fantail darter and rainbow darter were 30.8-36.0^{o}C and 30.0-36.4^{o}C, respectively. This may restrict the greenside darter to cooler and more thermally stable sections of streams during the summer months. Greenside darter are also less tolerant of low oxygen during summer (loss of equilibrium at 3.39 mg/l) than rainbow darter (1.64 mg/l) and fantail darter (2.36 mg/l) (Holohowskyj and Wissing 1987). The combination of oxygen and temperature tolerances would explain the absence of greenside darter from smaller headwater sections of warmwater streams in the summer months and, perhaps, their preference for highly oxygenated riffle habitats.

Olfaction may be important in greenside darter habitat selection. McCormick and Aspinwall (1983) experimentally demonstrated that greenside darter preferred natural vegetation over olfactory neutral artificial vegetation in a gradient choice chamber.

Dispersal/Migration

As a small fish without a swim bladder, the greenside darter appears adapted to a somewhat sedentary, benthic lifestyle. The greenside darter does not appear to undertake long-distance migrations, although substantial movements associated with spawning have been reported. Fahy (1954) did not observe any migratory movements in a New York stream and observed fish of all ages within the same riffle throughout the year. Winn (1958a) and Bunt *et al.* (1998) observed upstream migration to impassable barriers during the spawning season. In one Michigan stream, greenside darter migrated "several miles" upstream to breed in areas that dried up later in the summer and fall (Winn 1958a). During these migrations, males may migrate slightly ahead of females (Winn 1958a). Downstream movement has been observed after spawning (Winn 1958a; Trautman 1981) as well as during the summer in response to decreasing flows (Winn 1958a). Reed (1968) found small-scale movements between adjacent riffles and pools, although many individuals remained in the same riffle over a six-week period during the summer. The rapid spread of the greenside darter within the Potomac River in West Virginia, Virginia, Pennsylvania and Maryland (Jenkins and Burkhead 1994), and within the Grand River in Ontario, provides evidence of its dispersal abilities.

Interspecific interactions

The rainbow darter is the most common associate of the greenside darter throughout its range, although most regional darter assemblages can be associated with the greenside darter because of their wide selection of habitats (Kuehne and Barbour 1983). In Canadian streams, greenside darter are often associated with rainbow darter and fantail darter in riffle habitats. Competition may be reduced between these species through selection of different microhabitats and foraging modes. The greenside darter tends to prefer deeper and swifter sections of riffles with larger substrate than the other two species (Englert and Seghers 1983; Hlohowskyj and Wissing 1986), and forages on top of rocks, while the fantail darter is adapted to feeding in crevices (Hlohowskyj and Wissing 1986; Welsh and Perry 1998). Bunt *et al.* (1998) found that the stonecat was the only common benthic fish found in the same riffle as the greenside darter below the Mannheim Weir in the Grand River, Ontario. They suggested that these species co-exist through temporal and habitat food partitioning as the stonecat is nocturnal and the greenside darter is primarily active during the day.

The presence of filamentous algae (*Cladophora* spp.), aquatic mosses or other vegetation in riffle habitats, is important to provide egg-laying sites in the spring. This type of habitat appears to be abundant in the streams within the Canadian range of the greenside darter.

Adaptability

The greenside darter can be found in a wide range of habitats. It has remained abundant and widespread in the major river systems of agricultural southern Ontario, suggesting it is tolerant of nutrient enrichment, siltation and other habitat disturbances

that have resulted in the decline of other species at risk (fishes and mussels). The recent range expansion in Ontario and elsewhere within its range demonstrate the greenside darter's ability to exploit new habitats as they become available.

POPULATION SIZES AND TRENDS

Search effort

No targeted surveys have been conducted for greenside darter in Canada, although several recent surveys have targeted areas where fish species at risk are known to occur. Many greenside darter records are from general stream inventory work or surveys for other purposes. Throughout most of the greenside darter's Canadian range, pre-1970 sampling effort was sparse and was conducted with seine nets and minnow traps. During the 1970s, the OMNR conducted stream surveys, which included systematic fish sampling using a variety of gear types (including backpack electrofishing) throughout most streams, rivers and their major tributaries. The OMNR conducted a standard nearshore seining program along the south shore of Lake St. Clair from 1979 to 1981 and from 1990 to 1996. Such surveys covered most of southwestern Ontario, including the areas into which it has subsequently expanded. Although not specifically directed to any one species, greenside darters were recorded when present (A. Dextrase unpubl. data). Over the last 10 years, specific surveys have been conducted using a variety of gear types by Conservation Authorities, Fisheries and Oceans Canada, the Ontario Ministry of Natural Resources, and the Royal Ontario Museum, targeting historic locations and potential habitats for species at risk in the Ausable River, Bayfield River, Big Creek, Big Otter Creek, Detroit River, Grand River, St. Clair River, Sydenham River, and Thames River watersheds. Similar surveys have also been conducted in Lake Erie (Holiday Beach, Long Point, Pelee Island, Point Pelee, Port Burwell, Rondeau Bay) and Lake St. Clair. While these surveys have not provided complete coverage within the range of the greenside darter, they have added greatly to our knowledge of its distribution. Since the late 1990s, Conservation Authorities have conducted systematic fish sampling of agricultural drains in most southwestern Ontario watersheds as part of a drain classification project. Many of these drains are natural or semi-natural watercourses and this work has provided valuable information on the distribution of fishes in the smaller tributaries of many watersheds. In addition to the surveys described above, greenside darter records have been contributed by government and conservation authority staff, consultants and students who have conducted sampling for other purposes. There are few sampling locations where similar gear and effort have been used through time to allow an analysis of population trends. Poos (2004) found that backpack electrofishers were more efficient for detection and capture of greenside darter than seine nets.

Abundance

There are no estimates of absolute abundance for greenside darter populations in Canada. Given the number of locations at which the greenside darter is found, and its

apparent abundance at some sites (e.g., average of 65 per site at 62 sites in the Sydenham River), there are likely more than 10,000 individuals in Canada. Recent survey efforts in some watersheds can be used to make some general statements regarding relative abundance.

Ausable River - The greenside darter was not discovered in the Ausable River until 1974. It is not clear if it was always present in the watershed because of limited sampling prior to the 1970s. Dalton (1991) raised concerns regarding the state of populations in the Ausable River watershed given the turbidity of the system and speculated that the species may be extirpated from the river. During a survey of 25 sites in 2002, the greenside darter was found at over half (13) of the sites surveyed with as many as 71 individuals captured at a single site (Dextrase et al. 2003). Species at risk surveys in 2004 captured greenside darter at 18 of 19 sites along the mainstem of the Ausable and Little Ausable rivers (Stewart and Veliz 2004). The greenside darter ranked third in abundance out of the 50 species encountered in the survey. Stewart and Veliz (2004) concluded that greenside darter populations in the Ausable River basin were abundant and stable.

Sydenham River - The greenside darter was first discovered in the East Sydenham River near Strathroy in 1927 (Dextrase *et al.* 2001). Sampling in the 1970s revealed that the species was also present in Bear Creek in the North Sydenham drainage. Sampling conducted in 1997 captured the greenside darter throughout much of the East Sydenham River from Strathroy downstream to Wallaceburg, as well as at historical sites in Bear Creek. Substantial numbers were captured at some of the sites (e.g., 46 and 62 individuals at two sites) (Holm and Boehm 1998a). The greenside darter was the tenth most numerous and eighth most frequently encountered species of the 52 fish species found during systematic sampling of the Sydenham River watershed in 1997 (Holm and Boehm 1998a). It was captured at 11 of 23 sites with an average of 14 individuals per capture site. More recently, Poos (2004) conducted systematic sampling in 2002 and 2003 at 100 sites (including 25 sites that were sampled in both years) and captured greenside darter at 62 of these sites. The greenside darter was the third most numerous and eighth most frequently encountered species of 67 fishes, with an average of 65 individuals per capture site (M. Poos, University of Toronto, Toronto, Ontario, unpubl. data). Dalton (1991) suggested that numbers of greenside darter may be reduced in the Sydenham River; however, recent survey work suggests that the species is widespread and abundant in this watershed.

Lake St. Clair - There are few records of greenside darter from Lake St. Clair. Dalton (1991) reported only one record from the lake from 1959. A nearshore seining program was conducted by the Ontario Ministry of Natural Resources from 1979 to 1981, and from 1990 to 1996, along the south shore of Lake St. Clair (M. Belore, pers. comm. 2005). No greenside darter were captured from 1979 to 1981, but 48 were captured (including six young-of-the-year) at four different locations in 5 of 7 years during the 1990-1996 sampling period. This coincides with the changed habitat conditions associated with the zebra mussel invasion (see Habitat Trends above).

Thames River - The greenside darter was first recorded in the Thames River in 1884, and there are now more than 500 records for this species in the watershed (Cudmore *et al.* 2004). Sampling conducted primarily in agricultural drains from 1999 to 2002, found greenside darter at 52 of 236 sample sites throughout the Thames River watershed. The greenside darter appears to be abundant throughout the Thames River's main branches, and most of the tributaries that have been sampled (Cudmore *et al.* 2004). Dalton (1991) suggested that numbers of greenside darter may be reduced in the Thames River; however, recent survey work suggests that the species is present at almost all of the historical locations in the watershed and that it has remained abundant under current conditions. It may be limited by the high turbidity in the lower end of the river (Cudmore *et al.* 2004).

Grand River - The greenside darter was first captured in the Grand River watershed in 1990, from the Speed River near its confluence with the Eramosa River in Guelph (Fig. 5). Significant fish sampling was conducted in the watershed prior to 1990, including significant sampling in the area of first capture during the 1970s and 1980s (Fig. 5); therefore, it is highly unlikely that this distinctive species was overlooked in previous surveys. The introduction pathway for greenside darter into the Grand River watershed is not known. Given its first appearance upstream in the northeastern portion of the watershed (separated from Lake Erie by several dams), it is likely that the introduction was human-mediated as opposed to natural upstream invasive movements or stream capture from the adjacent Thames River watershed. The subsequent downstream and upstream colonization of the watershed has been rapid and was described by Bunt *et al.* (1998) as a "localized population explosion". In 15 years, the greenside darter has become established in more than 200 stream km. Their current upstream distribution along the Conestogo and Grand rivers ends at the Conestogo Lake dam and Elora Gorge, respectively. Three dams on the main stem of the Grand River are equipped with fishways. Bunt *et al.* (1998) demonstrated that greenside darter were able to move upstream through a Denil fishway at one of these dams when trash racks had not been properly maintained. Greenside darter have also been found upstream of barriers not equipped with fishways in the Speed River (Reid 2004) and MacKenzie Creek (S. Reid, pers. comm. 2005). The greenside darter is an abundant riffle-dwelling darter where it occurs in the Grand River (Bunt *et al.* 1998; Holm and Boehm 1998b). Portt *et al.* (2004) speculated that the introduction of the greenside darter is unlikely to alter the overall distribution of other darters in the Grand River (based on their co-occurrence in adjacent watersheds), although some changes in abundance and micro-habitat use may occur.

There is no information available with respect to abundance of greenside darter populations in the Bayfield River, Big Creek, Big Otter Creek, Detroit River and Pefferlaw Brook. The Pefferlaw Brook population is considered to have been the result of a human introduction; thus it is not considered in the assessment. The Grand River population was included in the assessment as it is uncertain whether or not it was introduced there, or was the result of a range expansion.

Fluctuations and trends

There is not sufficient information available to assess population trends other than in a very general sense. The greenside darter remains a widespread and abundant species in the Ausable River, Sydenham River and Thames River. Its range, and presumably its abundance, appear to have increased in the Ausable and Sydenham watersheds. Abundance may have also increased in Lake St. Clair. The species is still present in Big Creek, but there is no information regarding population trends. The total Canadian population of greenside darter has also increased through the recent colonization of the Bayfield River, Big Otter Creek, Detroit River, Grand River and Pefferlaw Brook.

Rescue effect

The rapid establishment and spread of the greenside darter in the Grand River system demonstrates the species' ability to colonize suitable habitat. A similar rapid range extension was recently documented in the Susquehanna River in Pennsylvania and Maryland (Neely and George 2006).

The greenside darter is present in four American states adjacent to its Canadian range. It is considered common in Michigan (S4) (NatureServe 2006) where it occurs in the southeastern portion of the Lower Peninsula. Populations are present in tributaries to the St. Clair River, Lake St. Clair and western Lake Erie as well as in the Detroit River (Bailey *et al.* 2004), providing possible sources of rescue for Canadian populations. The greenside darter was found in the Canadian portion of the Detroit River for the first time in 1995, and these fish may have originated from the Michigan side of the river (see Canadian range above). Although the greenside darter is not ranked in Ohio (SNR), it is a widespread species in the state (Trautman 1981), and was collected at over 2,000 sites from 421 Ohio streams between 1979 and 1995 (Sanders *et al.* 1999). Ohio fish would have to traverse the waters of Lake Erie to colonize Ontario streams. Although the greenside darter was once common around the western islands and south shore of the Ohio waters of Lake Erie, its abundance has declined in these areas (Van Meter and Trautman 1970; Trautman 1981). The greenside darter is common in Pennsylvania (S5) (NatureServe 2006) and is one of the most common darters in western Pennsylvania (Cooper 1983), but only a small portion of the state abuts the southern shore of Lake Erie. No greenside darter have been collected from the Canadian waters of Lake Erie, so it seems unlikely that populations from Ohio or Pennsylvania would rescue Canadian populations. The greenside darter is less common in New York (S3) (NatureServe 2006) and is sparsely distributed in tributaries to the Niagara River near the Canadian border (Smith 1985). No greenside darter have been found in Canadian tributaries to the Niagara River (A. Yagi, pers. comm. 2005), suggesting that rescue from New York populations is also unlikely.

LIMITING FACTORS AND THREATS

There are several potential threats to greenside darter populations in Canada, but none appear to be imminent or currently having a significant impact on populations. Dalton (1991) suggested that the food, habitat and breeding areas of the greenside darter are specialized, and that any disturbance of these resources would reduce populations. It is likely that such disturbances would need to be large in magnitude to have a significant impact.

Impoundments exist on all of the river systems where greenside darter are found in Ontario. Impoundments can destroy habitat by flooding upstream riffles and reducing flows downstream (Dalton 1991). Bunt *et al.* (1998) found that an impoundment on the Grand River had rendered upstream habitat unsuitable; however, Reid (2004) found the greenside darter at several sites in Guelph Lake (a large impoundment in the Speed River portion of the Grand River drainage), demonstrating that lentic habitats can be colonized. Bunt *et al.* (1998) suggested that the Mannheim Weir played an important role in the creation and maintenance of habitat preferred by the greenside darter (unembedded cobble substrate that supported thick growths of *Cladophora*). Impoundments that lack fish passage facilities prevent greenside darter from moving upstream, but do not appear to restrict downstream movements. The discovery of greenside darter above barriers without fishways, suggests ongoing human-mediated transport within the Grand River watershed.

Sediment and nutrient inputs associated principally with agricultural activities have been identified as primary threats limiting aquatic species at risk in the Ausable, Sydenham and Thames river watersheds (Nelson *et al.* 2003; Staton *et al.* 2003; Taylor *et al.* 2004). These factors do not seem to have affected greenside darter populations which have maintained or expanded their range in these systems. The high nutrient levels in these watersheds may have, in fact, benefited greenside darter populations by promoting the growth of filamentous algae and other vegetation. Excessive sedimentation could impact greenside darter habitat by increasing imbeddedness of rock substrates and increased turbidity could result in decreased growth of aquatic vegetation.

Contaminants associated with industrial activity and agricultural runoff have the potential to kill greenside darter outright, or to affect their insect food supply (Dalton 1991). At least four separate chemical or fertilizer spills have occurred within the Ausable, Grand, Sydenham and Thames river watersheds in the last 7 years that have resulted in fish kills (A. Dextrase, unpubl. data). Although the impacts of these spills are localized and short-lived, they can be significant. A chemical spill into the Ausable River at Exeter in April 2005 caused a fish kill along a 5.1 km reach of the river. A sub-sample of 60 m of river revealed 242 dead fishes of 20 species including 7 greenside darter (S. Staton, pers. comm. 2005). If the sampled section of stream was representative of the entire kill zone, then more than 700 greenside darter may have been lost to this spill. Chronic levels of contaminant inputs, currently present, do not appear to have negatively affected greenside darter populations. Greenside darter

populations in the Detroit River and Lake St. Clair are vulnerable to contaminant runoff and spills associated with large urban centres, shipping and the chemical industry upstream along the St. Clair River. Cannon *et al.* (1992) found that greenside darter were present in a Pennsylvania stream that had been impacted by acid mine drainage (elevated iron and sulfate levels, heavy coating of precipitate on substrate), but that other sensitive benthic fishes were absent.

Large urban centres are present within the range of the greenside darter in the Thames River (London) and Grand River (Brantford, Cambridge, Guelph, Kitchener-Waterloo). Growth of these urban communities is proceeding rapidly – the population of the Grand River watershed is projected to increase by 30% over the next 20 years (GRCA 2005). Urban expansion has the potential to degrade or destroy habitat, and to increase contaminant inputs into these systems.

The introduced round goby is a potential threat to greenside darter populations in Ontario. It was first found in North America in the St. Clair River in 1990 (Jude *et al.* 1992), has since spread to each of the Great Lakes, and has become locally abundant in some areas. Predation and competition from the round goby has been implicated in declines of mottled sculpin (*Cottus bairdii*), and possibly logperch, populations in the St. Clair River (French and Jude 2001), but impacts on greenside darter populations have not been specifically studied. Ontario ranges of the round goby and greenside darter currently overlap in the Detroit River, Pefferlaw Brook and Lake St. Clair. The round goby has the potential to invade most of the river systems that currently support greenside darter populations.

SPECIAL SIGNIFICANCE OF THE SPECIES

The greenside darter is often abundant where it occurs in Ontario and, as such, it likely plays an important role in converting benthic energy in lotic ecosystems where it serves as prey for piscivorous fishes and other vertebrates. Laboratory work has shown that the greenside darter can serve as a glochidial host for the Rayed Bean (*Villosa fabalis*), one of Canada's endangered freshwater mussels (McNichols and Mackie 2003). It has also been shown to serve as a glochidial host for the endangered Cumberlandian Combshell (*Epioblasma brevidens*) in the United States based on experimental infections (Yeager and Saylor 1995).

The greenside darter is of considerable interest for scientific studies (Scott and Crossman 1973), and has been the subject of significant investigation in both the field and the laboratory. It has no known commercial value, although it might be harvested incidentally as a bait fish. The greenside darter is one of Canada's most colourful freshwater fishes and, therefore, may be of interest as an aquarium fish.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

As a Special Concern species from 1990 to the current reassessment (2006), the greenside darter is not protected by any federal or provincial species at risk legislation in Canada. The greenside darter is a legal baitfish in Ontario, and may be harvested for use as bait by licensed anglers and commercial bait harvesters. There is no evidence to suggest that this species is a preferred or sought-after bait species (Coker *et al.* 2001), although some may be harvested incidentally.

The greenside darter was assessed as Special Concern by COSEWIC in 1990 (COSEWIC 2004), and is also listed as Special Concern under Schedule 3 of the federal *Species at Risk Act* and on the Species at Risk in Ontario List. It has been ranked as sensitive at the provincial and national levels by the General Status of Wild Species in Canada. The greenside darter is considered globally secure (G5) and is ranked as secure (S4 or S5) in most American states where it occurs (Table 1). It is ranked as S1 in Mississippi where it is a state endangered species (Mississippi Natural Heritage Program 2002), and it is ranked as S2 in Kansas where it is listed as a species in need of conservation (Kansas Natural Heritage Inventory 2005). The subnational rank for this species in Ontario is S4.

Table 1. Global, national and subnational heritage ranks for the greenside darter (*Etheostoma blennioides*) (NatureServe 2006).

Rank level	Rank	Jurisdictions
Global	G5	
National	N5	United States
	N4	Canada
Subnational	S5	Maryland, Oklahoma, Pennsylvania, Tennessee, West Virginia
	S4S5	Kentucky
	S4	Arkansas, Indiana, Michigan, North Carolina, Virginia, Ontario
	S3S4	Georgia
	S3	Alabama, Illinois, New York
	S2	Kansas
	S1	Mississippi
	SH	District of Columbia
	SNR	Missouri, Ohio

TECHNICAL SUMMARY

Etheostoma blennioides
greenside darter dard vert
Range of Occurrence in Canada: Ontario

Extent and Area Information	
• *Extent of occurrence (EO)(km²)* [calculated from Fig. 4]	~38,400 km²
• *Specify trend in EO*	increasing
• *Are there extreme fluctuations in EO?*	no
• *Area of occupancy (AO) (km²)* [calculated from Fig. 1 – Bayfield River <1 km^2, Ausable River – 160 km x 10 m = 1.6 km^2, Sydenham River – 200 km x 10 m = 2.0 km^2, Lake St. Clair – 10 km^2, Thames River – 387 km x 30 m = 11.6 km^2, Detroit River ~1 km^2, Big Otter Creek < 1 km^2, Big Creek < 1 km^2, Grand River – 210 km x 30 m = 6.3 km^2]	32 km²
• *Specify trend in AO*	increasing
• *Are there extreme fluctuations in AO?*	no
• *Number of known or inferred current locations*	10 tertiary watersheds (76 element occurrences)
• *Specify trend in #*	increasing
• *Are there extreme fluctuations in number of locations?*	no
• *Specify trend in area, extent or quality of habitat*	increasing
Population Information	
• *Generation time (average age of parents in the population)*	2 years
• *Number of mature individuals*	Unknown, but probably more than 10,000
• *Total population trend:*	
• *% decline over the last/next 10 years or 3 generations.*	n/a – increasing population trend
• *Are there extreme fluctuations in number of mature individuals?*	no
• *Is the total population severely fragmented?*	no
• *Specify trend in number of populations*	increasing
• *Are there extreme fluctuations in number of populations?*	no
• List populations with number of mature individuals in each:	population sizes are unknown
Threats (actual or imminent threats to populations or habitats)	
No immediate threats, potential threats include: • Sediment and nutrient inputs associated with agricultural activities • Contaminants from spills and runoff • Urban growth in the Thames and Grand River watersheds • Predation and competition from introduced round goby	
Rescue Effect (immigration from an outside source)	
• *Status of outside population(s)?* **USA**: Michigan (S4), Ohio (SNR). Pennsylvania (S5), New York (S3) – considered a common species in some adjacent U.S. jurisdictions.	
• *Is immigration known or possible?*	possible
• *Would immigrants be adapted to survive in Canada?*	yes

• *Is there sufficient habitat for immigrants in Canada?*	yes
• *Is rescue from outside populations likely?* **Quantitative Analysis** [provide details on calculation, source(s) of data, models, etc]	Possibly; insufficient information for quantitative analysis
Current Status COSEWIC: Special Concern (1990), Not at Risk (2006) SARA: Special Concern – Schedule 3 ONTARIO: Special Concern GENERAL STATUS – CANADA: Sensitive GENERAL STATUS – ONTARIO: Sensitive	

Status and Reasons for Designation

Status: Not at Risk	**Alpha-numeric code**: Not Applicable
Reasons for Designation: Recent surveys have shown that the species is widespread and abundant in the Ausable, Sydenham and Thames rivers as well as Lake St. Clair. The total Canadian population has also increased through the recent colonization of the Bayfield River, Big Otter Creek, Detroit River, and the Grand River. Rescue of greenside darter populations in Canada is possible from Michigan populations.	
Applicability of Criteria **Criterion A**: (Declining Total Population): Not applicable. EO, AO and population size appear to be increasing. **Criterion B**: (Small Distribution, and Decline or Fluctuation): Not applicable. Although the species is known to occur in 10 watersheds there is no evidence of decline. **Criterion C**: (Small Total Population Size and Decline): Not Applicable. Population size, although unknown, probably exceeds threshold and is likely increasing. **Criterion D**: (Very Small Population or Restricted Distribution): Not Applicable. AO exceeds threshold and is likely increasing; population size, although unknown probably exceeds 10,000 and is also increasing. **Criterion E**: (Quantitative Analysis): Not Applicable. Insufficient information for quantitative analysis.	

ACKNOWLEDGEMENTS AND AUTHORITIES CONSULTED

The following people provided unpublished data and advice that contributed greatly to the production of this status report: Muriel Andreae, Jason Barnucz, Megan Belore, Doug Carlson, Ken Cornelisse, Debbie Depasquale, Paul Gagnon, Scott Gibson, Tom MacDougall, Mark Poos, Scott Reid, John Schwindt, Shawn Staton, Jamie Stewart, Art Timmerman, Mari Veliz, and Anne Yagi. Erling Holm and Nick Mandrak graciously shared their extensive distribution databases. Bob Campbell and several reviewers provided valuable advice and suggestions on earlier versions of this manuscript. Finally, financial support from the Ontario Ministry of Natural Resources and the support of Steve Bowcott (OMNR) are gratefully acknowledged.

Authorities contacted

Muriel Andreae, St. Clair Region Conservation Authority, Strathroy, Ontario
Jason Barnucz, Fisheries and Oceans Canada, Burlington, Ontario
Megan Belore, Ontario Ministry of Natural Resources, Wheatley, Ontario
Douglas Carlson, New York Department of Environmental Conservation, Watertown, New York, United States
Ken Cornelisse, Ontario Ministry of Natural Resources, Guelph, Ontario
Debbie Depasquale, University of Guelph, Guelph, Ontario
Paul Gagnon, Long Point Region Conservation Authority, Port Rowan, Ontario
Scott Gibson, Ontario Ministry of Natural Resources, Bracebridge, Ontario
Gloria Goulet, COSEWIC Secretariat, Ottawa, Ontario
Erling Holm, Royal Ontario Museum, Toronto, Ontario
Tom MacDougall, Ontario Ministry of Natural Resources, Port Dover, Ontario
Nicholas Mandrak, Fisheries and Oceans Canada, Burlington, Ontario
Mark Poos, University of Toronto, Toronto, Ontario
Scott Reid, Ontario Ministry of Natural Resources, Peterborough, Ontario
John Schwindt, Upper Thames River Conservation Authority, London, Ontario
Shawn Staton, Fisheries and Oceans Canada, Burlington, Ontario
Jamie Stewart, Ausable-Bayfield Conservation Authority, Exeter, Ontario
Art Timmerman, Ontario Ministry of Natural Resources, Guelph, Ontario
Mari Veliz, Ausable-Bayfield Conservation Authority, Exeter, Ontario
Anne Yagi, Ontario Ministry of Natural Resources, Vineland, Ontario
Warren Yerex, Grand River Conservation Authority, Cambridge, Ontario

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Alan Dextrase has a B.Sc. in Fisheries Biology from the University of Guelph and an M.Sc. in Biology from Lakehead University. After graduating, Alan worked for the Ontario Ministry of Natural Resources as a fisheries biologist in northwestern Ontario for 10 years where he worked on the management of recreational and commercial fisheries and fish and wildlife habitat management. Since 1993, he has worked as a biologist for OMNR in Peterborough, Ontario where he has worked on the management of invasive species and species at risk. He is currently the Senior Species at Risk Biologist in the Fish and Wildlife Branch. Alan has been a member of COSEWIC and the COSEWIC Freshwater Fishes Specialist Subcommittee since 1994 and is a member of several recovery teams for freshwater species at risk in Ontario.

COLLECTIONS EXAMINED

At the request of the author, Erling Holm verified one accessioned greenside darter specimen from the Bayfield River in the Royal Ontario Museum (ROM 75857).