Review Considerations and Mitigation Guide for Habitat of the Grass Pickerel (*Esox americanus vermiculatus*)

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REVIEW CONSIDERATIONS AND MITIGATION GUIDE FOR HABITAT OF THE GRASS PICKEREL (*Esox americanus vermiculatus*)

by

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ABSTRACT

Coker, G.A., Ming, D.L., and Mandrak, N.E. 2010. Review considerations and mitigation guide for habitat of the Grass Pickerel (*Esox americanus vermiculatus*). Can. Manuscr. Rep. Fish. Aquat. Sci. 2941: vi + 18 p.

The Grass Pickerel (*Esox americanus vermiculatus*) is a member of the Pike family and a subspecies of the Redfin Pickerel (*Esox americanus*). The Canadian distribution includes southwestern Quebec and southern Ontario. It has been designated as a species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada and is listed on Schedule 1 of the federal *Species at Risk Act*. The Grass Pickerel frequently occupies the niche of top predator in heavily vegetated, shallow, low velocity habitats where habitat conditions are unsuitable for larger top-predators. Despite being rather resilient to natural variations in environmental conditions, Grass Pickerel has fairly specific habitat requirements that result in a highly disjunct distribution in Ontario. Threats to this species include, but are not limited to, habitat degradation and destruction through channel alterations that result in the loss of aquatic vegetation and other cover types, as well as the loss of low-velocity and shallow habitats. Mitigation strategies are proposed to minimize the impacts of watercourse modifications to this species.

RÉSUMÉ

Coker, G.A., Ming, D.L., and Mandrak, N.E. 2010. Review considerations and mitigation guide for habitat of the Grass Pickerel (*Esox americanus vermiculatus*). Can. Manuscr. Rep. Fish. Aquat. Sci. 2941: vi + 18 p.

Le brochet vermiculé (*Esox americanus vermiculatus*) est un membre de la famille des brochets et une sous-espèce du brochet d'Amérique (*Esox americanus*). Son aire de répartition canadienne comprend le sud-ouest du Québec et le sud de l'Ontario. Il a été désigné comme une espèce préoccupante par le Comité sur la situation des espèces en péril au Canada et figure à l'annexe 1 de la *Loi sur les espèces en péril* fédérale. Le brochet vermiculé occupe souvent la niche du prédateur supérieur dans les habitats peu profonds, à forte végétation et à courant réduit, où les conditions sont défavorables aux plus grands prédateurs supérieurs. Malgré sa résilience aux variations naturelles des conditions ambiantes, le brochet vermiculé a des exigences assez précises en matière d'habitat qui donnent lieu à une répartition très disjointe de l'espèce en Ontario. Les menaces à celle-ci comprennent, entre autres, la dégradation et la destruction de l'habitat causées par les modifications des chenaux, lesquelles entraînent la perte de végétation aquatique et d'autres types de couvert, de même que la perte d'habitats à courant réduit et peu profonds. Des stratégies d'atténuation sont proposées pour réduire au minimum les répercussions des modifications des cours d'eau sur cette espèce.

INTRODUCTION

The Grass Pickerel (*Esox americanus vermiculatus*) (Figure 1) is a part of the Esocidae family, of which Northern Pike (*Esox lucius*) and Muskellunge (*E. masquinongy*) are well-known members. It is one of the few North American fish subspecies with a formally recognized common name, being a subspecies of the Redfin Pickerel (*E. americanus*). The native global distribution of *Esox americanus* is restricted to the eastern half of North America, with the Grass Pickerel subspecies occurring in the central Mississippi valley and the southern Great Lakes basin, the Redfin Pickerel subspecies (*E. a. americanus*) occurring on the east Atlantic slope, and intergrades between the two subspecies occurring on the Gulf of Mexico slope (Jenkins and Burkhead 1993). In Canada, the Grass Pickerel is limited to extreme southwestern Quebec and southern Ontario (COSEWIC 2005).

The Grass Pickerel has been designated "Special Concern" in Canada since May 2005, based upon the most recent status report of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2005), and is listed in Schedule 1 of the *Species At Risk Act* (SARA). Schedule 1 is the official list of wildlife species at risk in Canada. The reason for designation is that it is only known from 10 locations between Lake St. Louis, Quebec and Lake Huron, Ontario, and an overall decline of approximately 22% in the area of occupancy has been observed since 1970. This decline appears to be related to degradation and loss of habitat due to channelization and dredging operations in wetland habitats where this species occurs (COSEWIC 2005).

The purposes of the SARA are to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened. The Minister of Fisheries and Oceans is responsible for aquatic species listed under the SARA, including freshwater fishes and mussels. Once a species is listed on Schedule 1 under the SARA, it becomes illegal to kill, harass, capture or harm it in any way. Critical habitats are also protected from destruction. The *Act* also requires that recovery strategies, action plans and management plans be developed for all listed species. Fisheries and Oceans Canada (DFO) is responsible for the coordination of recovery strategies and action plans for endangered and threatened aquatic species at risk. It is important to remember that there may be provincial and/or municipal and/or Conservation Authority policies that also pertain to species at risk.

This document provides a summary of Grass Pickerel life history and habitat information for government regulators and project proponents, pertinent to the assessment of development projects or other phenomena that affect Grass Pickerel habitat. Potential strategies to mitigate the harmful alteration, disruption and destruction of Grass Pickerel habitat are also provided.

BACKGROUND INFORMATION

ECOLOGICAL SIGNIFICANCE

The Grass Pickerel is often the top predator in fish communities of which it is characteristic (COSEWIC 2005) and may have a significant role in the control of populations of small fishes (Jenkins and Burkhead 1993). Grass Pickerel is tolerant of a broad range of temperature, oxygen, and some stream physical habitat components, and may utilize an ecological niche in shallow, densely vegetated, habitats that larger top predators cannot. A broad complex of warmwater species is usually associated with the Grass Pickerel (Scott and Crossman 1973).

GENERAL HABITAT

The usual habitat for Grass Pickerel is water of mildly acidic to slightly basic nature, clear to tea coloured, with very slow to no flow, generally shallower than 2 m, with abundant to dense submerged, floating, and emergent aquatic vegetation (COSEWIC 2005). It is a resident of small, slow moving, mud or muck bottomed, heavily vegetated lowland streams and the small pond-like expansions of those streams, or overflow ponds of larger streams. Less commonly, it is found in quiet weedy bays of lakes (Crossman 1962; Scott and Crossman 1973). Although Canadian Grass Pickerel populations are usually associated with mud substrates, they have been found in areas of gravel and rock (COSEWIC 2005). Photographs of common Grass Pickerel habitat are presented in Figures 2 to 6.

The Grass Pickerel reportedly moves infrequently, and only for short distances, to hunt for food and shelter (Crossman 1962; Becker 1983), although spawning aggregations have been reported in lakes (Kleinert and Mraz 1966). Preliminary results of a study in Beaver Creek, a Niagara stream, indicate that some PIT-tagged individuals moved approximately 4 km within several months of being tagged in May (J. Barnucz, DFO, 867 Lakeshore Road, Burlington, Ontario, L7R 4A6, pers. comm.).

Grass Pickerel is an ambush predator and is found in low velocity habitats. Cain et al. (2008) reported that all individuals captured in their study (n=378) were found in low flow areas, generally runs or pools - none were captured in riffles. Becker (1983) stated that Grass Pickerel attains its highest population densities in shallow weedy locations. The vegetative communities typically occupied by Grass Pickerel are similar to that in which Northern Pike and Muskellunge are found, and include representatives of the pondweeds (*Potamogeton* spp.), coontail (*Ceratophyllum* spp.), water lilies (*Nymphaea* spp. and *Nuphar* spp.), and *Chara* (COSEWIC 2005). In a Wisconsin study, plants associated with Grass Pickerel were moss (*Dreplanocladus* spp.), water lilies, pondweeds, filamentous algae, and Broadleaf Cattail (*Typha latifolia)* (Kleinert and Mraz 1966). Ming noted that in Oklahoma it was sometimes found in rock or gravel pools without vegetation, associated in these cases with a brush pile or overhanging bush (as cited in COSEWIC 2005, pg. 8). Cain et al. (2008) reported that at all nine Grass Pickerel capture sites where microhabitat analysis was conducted, Grass Pickerel was associated with either aquatic macrophytes (n=7) or woody debris (n=2), and that relative abundance of these cover types was positively correlated (r^2=0.57, p=0.03) with Grass Pickerel catch. While the substrate associated with Canadian populations is usually mud or muck, it is known to occur in areas of gravel and rock (COSEWIC 2005). The frequency of substrates encountered with this species in Wisconsin habitats is listed as sand (21%), gravel (21%), mud (17%), clay (13%), rubble (13%), silt (8%), and boulders (8%) (Becker 1983). In winter, Grass Pickerel may burrow in mats of fallen leaves (Etnier and Starnes 1993).

COSEWIC (2005) stated that the water is characteristically clear in Grass Pickerel habitat, but Becker (1983) stated that it is found in clear to turbid water. Trautman (1981) observed that Grass Pickerel decreased in numbers, or became extirpated, wherever an increase in turbidity destroyed the aquatic vegetation. Increases in turbidity had a negative impact on Grass Pickerel feeding in Long Point Bay (COSEWIC 2005).

The preferred water temperature for Grass Pickerel is 26°C (Crossman 1962; Wismer and Christie 1987); however, it tolerates temperatures up to 29°C, which is an adaptation to shallow, still-waters that can warm rapidly (Scott and Crossman 1973; Coad et al. 1995). Cain et al. (2008) reported Grass Pickerel surviving in streams with water temperatures as high as 32°C in Indiana. The Grass Pickerel is also adapted to low dissolved oxygen levels, as low as 0.4 - 0.3 mg/L (Crossman 1962; Scott and Crossman 1973), which allows it to utilize heavily vegetated, slow moving or still, shallow water that can become depleted of oxygen at night due to plant respiration.

SPAWNING

In Ontario, spawning takes place in water temperatures approximately 8-12°C (late March to early May), eggs hatch in 11-15 days at temperatures of 7.8-8.9°C, and the time period between spawning to initiation of feeding by young is 2-5 weeks depending on water temperature (COSEWIC 2005). Becker (1983) stated that spawning occurs at 4.4-11.7°C. No nest is built; the eggs are broadcast and abandoned, settling and adhering to vegetation (Becker 1983). Besides the main spring spawning period, there is evidence that a low intensity fall spawning occurs (Crossman 1962; Kleinert and Mraz 1966).

Neither reproductive migration nor homing are known (COSEWIC 2005), although, some older published sources refer to spawning migrations (Crossman 1962; Scott and Crossman 1973), which are apparently based upon even older sources, or upon the assumption that the spawning behaviour of the Grass Pickerel would be similar to that of Northern Pike (*Esox lucius*), which does migrate. However, there is evidence that local movement to preferred spawning habitat does occur. Kleinert and Mraz (1966) observed that Grass Pickerel aggregated in a shallow slough attached to Pleasant Lake, Wisconsin, which warmed more quickly than the rest of the lake in the spring. The slough could become dry during periods of low precipitation. Although a few Grass Pickerel could be seen scattered about the other shorelines and bays of the lake, suggesting that spawning occurred in many locations, eggs and fry were abundant only in the slough and were difficult to find elsewhere in the lake. During the spawning period, Grass Pickerel was most often seen in groups of two to six or more fishes in the shallow water bordering the margin of the slough (Kleinert and Mraz 1966). In support of these observations, adults of the closely related Redfin Pickerel congregate in small groups to spawn in shallow, heavily vegetated areas such as flooded pond banks or stream margins (Jenkins and Burkhead 1993), as well as in floodplains, overflow areas, and along grassy stream banks (Smith 1985). Such floodplain habitats in the Niagara area also act as nursery habitat for Grass Pickerel (J. Barnucz, DFO, 867 Lakeshore Road, Burlington, Ontario, L7R 4A6, pers. comm.).

ADAPTABILITY

As exemplified by its highly disjunct distribution in Ontario, the Grass Pickerel has rather specific habitat requirements. However, it is highly resilient to the natural extremes in water level, flow, and temperature that are typical for its preferred habitat (Scott and Crossman 1973). Where suitable habitat is present, it may be found in relatively high numbers inside and outside of its native range (COSEWIC 2005).

THREATS TO THE GRASS PICKEREL

All conditions resulting in low water levels, loss of aquatic vegetation, decreased water transparency, and lowering of stream temperatures are threats to the Grass Pickerel (COSEWIC 2005). Other potential threats are the general degradation of water quality, the fragmentation of habitats, and the loss of still-water habitats.

The DFO Risk Management Framework (RMF) contains a complex list of Pathways of Effects (PoEs) that identify the various impacts upon fish habitat due to a particular activity, upon which mitigating actions can be applied. Table 1 lists the potential threats to the Grass Pickerel and the associated PoEs (Coker et al. 2010). For more information on the RMF, refer to DFO's *Practitioner's Guide to the Risk Management Framework for DFO Habitat Management Staff Version 1.0* (DFO 2006).

CONSIDERATIONS FOR THE PLANNING AND REVIEW OF PROPOSED WORKS THAT MAY IMPACT GRASS PICKEREL HABITAT

The effects of urbanization and agricultural practices upon watercourses and waterbodies, either through direct impacts within these areas, or through indirect impacts from adjacent land-use practices, encompass most of the threats to Grass Pickerel populations. The following impacts on and potential mitigation measures for Grass Pickerel habitat should be considered in project planning and review.

DIRECT DESTRUCTION AND ALTERATION OF HABITAT

Mechanism of Potential Impacts

The alteration of watercourses and associated wetlands, through ditching, channelization, deepening, or filling, can remove the cover, either aquatic vegetation or woody debris, that is an important component of Grass Pickerel habitat and the shallow vegetated habitats required for spawning. If the watercourse is sufficiently deepened, or the substrate altered, the aquatic vegetation may not regenerate to its original quantity or quality. Trautman (1981) noted that the Grass Pickerel decreased in numbers, or became extirpated, wherever ditching, dredging, or other forms of channelization destroyed its habitat, or where an increase in turbidity destroyed the aquatic vegetation. The ditching, channelization, and deepening of watercourses may also reduce or eliminate fish access to the flood plain, including sloughs and oxbow ponds, where spawning and nursery habitats may exist.

Negative impacts to Grass Pickerel may occur where the alteration of a watercourse results in the elimination or reduction of still-water habitats. The channelization of pool/riffle habitats results in the homogenization of flow velocity, reducing or eliminating both riffles and pools (pools are preferred by Grass Pickerel). Carline and Kloseiwski (1985) found that the density of Grass Pickerel increased significantly after the installation of wing deflectors within a previously channelized watercourse, which resulted in the development of a meandering flow pattern, the creation of pools, and an increase in the area of rooted macrophytes.

The results of a statistical analysis of Grass Pickerel habitat at 125 stream locations in Indiana (Cain et al. 2008) found that habitat use was primarily based upon the presence of in-stream cover and slow moving water. Grass Pickerel was always found in association with cover in the form of either aquatic macrophytes (77%) or logs/woody debris (23%). It was not found in riffle habitats. In addition, there was an associated increase in Grass Pickerel catch when the proportion of these cover types increased. Although Trautman (1981) stated that Grass Pickerel in Ohio has been shown to decrease in numbers or become extirpated in streams where channelization has destroyed habitat, Cain et al. (2008) found that Grass Pickerel will survive in areas of poor water quality as long as cover is present.

Alternatives and Mitigation

For the construction or rehabilitation of natural watercourses containing Grass Pickerel, the use of natural channel design principles must provide shallow areas of quiet water where submergent vegetation can establish and be maintained. Early spring flooded backwater areas for Grass Pickerel spawning habitat must remain flooded for at least 2-5 weeks, once their preferred spawning temperature is reached.

In the case of drain maintenance, it is important to identify the true cause of the drainage problem, which may result in employing strategies such as limited or spot cleanouts that will minimize habitat disruption, rather than an overall headwater to outlet approach. There may also be opportunities for the maintenance or development of areas that are seasonally flooded to a depth and length of time suitable for Grass Pickerel spawning with little impact upon agricultural land utilization. Other locations within a drain may be suitable for the construction of in-channel spawning terraces.

Another mitigation strategy to protect Grass Pickerel habitat from the impacts of drain maintenance activities is a phased approach to the cleanout of a drain. This concept involves cleaning out some sections of a drain while ensuring that other sections are left untouched until the habitat function of the maintained (dredged) sections return. Another strategy to mitigate the effects of drain maintenance would be to create pool habitat and provide cover, either woody debris or aquatic vegetation. Grass Pickerel has been observed in "pools" that had been dug wider and deeper than the rest of the watercourse for livestock watering during dry periods (C. Portt and G. Coker, C. Portt and Associates, 56 Waterloo Avenue, Guelph, Ontario N1H 3H5, pers. comm.).

Potential impacts from point-impact projects such as water crossings (e.g., culverts/bridges, pipelines) can be mitigated by using appropriate in-water work timing windows and sediment controls, and ensuring that fish passage is not permanently impaired. A reduction in Grass Pickerel abundance, likely due to the lack of adequate sediment controls, was observed at the site of a bridge on Twenty Mile Creek, Ontario, soon after it was rebuilt (N.E. Mandrak, DFO, 867 Lakeshore Road, Burlington, Ontario L7R 4A6, pers. comm.). Temporary disruptions to fish passage (e.g., temporary cofferdams to isolate and dewater a water crossing during construction or replacement) that occur outside of the early spring and fall periods, when Grass Pickerel is not expected to move between spawning areas and overwintering habitats, will likely have little detrimental effect upon Grass Pickerel populations. These projects should have little permanent impact upon the typically long stretches of Grass Pickerel habitats that occur in low-gradient watercourses.

POLLUTION AND DEGRADATION OF WATER QUALITY

Mechanism of Potential Impacts

Runoff from urban landscapes can contain pesticides, herbicides, and fertilizers from ornamental landscaping application; spills of chemicals and fuels; seasonal dumping of heavily chlorinated water from private swimming pools; and, de-icing salt applied to roads during the winter. Runoff from rural/agricultural landscapes typically contains pesticides, herbicides, and fertilizers that have been applied to crops. Cattle access to streams and runoff from stockyards can result in nutrient inputs. Besides the toxic effects of some of these pollutants upon Grass Pickerel and other stream organisms, excess algae growth due to nutrient inputs can also negatively impact aquatic plants and dissolved oxygen levels. However, Grass Pickerel is tolerant of low dissolved oxygen concentrations (Crossman 1962; Scott and Crossman 1973).

Water temperature, turbidity, conductivity, and dissolved oxygen data were collected at 83 sites in Indiana (Cain et al. 2008). Values for all of these factors, except temperature, were significantly related to Grass Pickerel catch, but the relationships were biologically weak. Grass Pickerel tolerated a liberal range of water quality conditions (Cain et al. 2008). Grass Pickerel was also found in association with both pollution tolerant species (Bluntnose Minnow (*Pimephales notatus),* Creek Chub (*Semotilus atromaculatus*), Green Sunfish (*Lepomis cyanellus*), White Sucker (*Catostomus commersonii*) and Yellow Bullhead (*Ameiurus natalis*)), and pollution intolerant species (Bluegill (*Lepomis macrochirus)* and Longear Sunfish (*Lepomis megalotis*)). Cain et al. (2008) concluded that the limiting factors for Grass Pickerel abundance in Indiana streams did not appear to be water quality related, but rather, tied to in-stream cover.

Alternatives and Mitigation

Adequate vegetated buffer zones along watercourses in both urban and rural settings can mitigate much of the overland transport and input of pollutants. Cattle and other livestock can be excluded from watercourses by fencing. Where pollutants find their way into storm sewer systems that discharge to Grass Pickerel habitat, appropriate stormwater quality treatment facilities should be installed to reduce these inputs.

SILTATION OF WETLANDS AND WATERCOURSES

Mechanism of Potential Impacts

Runoff from construction sites, streets and parking lots, and tilled fields can carry soil particles as bedload or suspended soil particles that can gradually fill wetlands and low-gradient watercourses and, at high concentrations, can also smother aquatic plants and benthic organisms. Very fine soil particles can remain suspended in the water column, blocking the sunlight necessary for submergent aquatic plant growth that is an important component of Grass Pickerel habitat. Turbid water at a duration and intensity commensurate with a seasonally typical rainstorm event is likely little threat to Grass Pickerel habitat; however, turbidity of extended duration or high intensity may negatively impact submergent aquatic plants. Cattle access to streams can result in the suspension of sediments and trampling of macrophytes. Trautman (1981) noted that the Grass Pickerel decreased in numbers when increased turbidity destroyed the aquatic vegetation. Increases in turbidity can also have a negative impact on Grass Pickerel feeding (COSEWIC 2005).

Alternatives and Mitigation

Grass Pickerel tends to be found in low gradient habitats with fine substrates and, thus, are probably less at risk from siltation than fish species that rely upon coarse substrates. Adequate vegetated buffer zones along watercourses and wetlands in both urban and rural settings can mitigate much of the overland transport of sediment to these waterbodies. Standard soil conservation methods, such as no-till cropping, grassed waterways and sediment catch basins, can reduce sediment from agricultural lands entering watercourses and wetlands. Likewise, standard practices for keeping soils on construction sites can be used to limit impacts from these sources. Where sediment finds its way into storm sewer systems that discharge to Grass Pickerel habitat, appropriate stormwater quality treatment facilities can remove some proportion of the suspended material.

LOW WATER LEVELS

Mechanism of Potential Impacts

Low water levels can be caused by drought, water extraction, and watercourse alteration that result in more efficient drainage. Besides reducing the habitat area available to Grass Pickerel, low surface water levels can also reduce access to shoreline, stream bank, or floodplain spawning and nursery areas. In a Wisconsin study, declining water levels due to drought, trapped and subsequently killed young and adult Grass Pickerel within a slough where spawning had occurred (Kleinert and Mraz 1966).

Alternatives and Mitigation

While little can be done to mitigate drought conditions, the effect upon Grass Pickerel habitat from changes in water levels caused by water extraction, watercourse alteration, or agricultural drain maintenance should be considered when evaluating the potential impacts of any proposed works or activities. Constructed refuge pools can provide habitat during dry periods, as concentrations of Grass Pickerel have been observed in "pools" that had been dug wider and deeper than the rest of the watercourse for livestock watering during dry periods (C. Portt and G. Coker, C. Portt and Associates, 56 Waterloo Avenue, Guelph, Ontario N1H 3H5, pers. comm.). If a fish habitat compensation plan includes the construction of Grass Pickerel habitat, multi-level spawning areas could be included that provide spawning habitat over the range of expected water levels.

DIVERSION OF COLD OR COOL WATER INTO GRASS PICKEREL HABITAT

Mechanism of Potential Impacts

Deepening of watercourses may intercept groundwater sources, possibly resulting in the lowering of water temperatures that may negatively impact this warmwater-adapted species. Infrastructure, such as sewers, water mains and foundation drains in buildings, can also intercept groundwater and divert it to watercourses. Stormwater management facilities can maintain flow and lower water temperatures in downstream watercourses for longer periods of time. Cooler water temperatures may have a detrimental impact upon Grass Pickerel, which is a warmwater species and at the northern limit of its range in southern Ontario and Quebec.

Alternatives and Mitigation

Avoiding or mitigating the effect of cool water discharge to important Grass Pickerel habitats should be considered during the construction of infrastructure or the deepening of watercourses. Stormwater management facilities can be designed to maintain or increase downstream water temperatures (e.g., top-draw or shallow facility).

MITIGATION GUIDANCE PROVIDED IN THE DRAFT MANAGEMENT PLAN FOR THE GRASS PICKEREL

In addition to the guidance provided above, the draft management plan for the Grass Pickerel (Beauchamp, J., Boyko, A.L., Hardy, D., Jarvis, P.L., Dunn, S., and Staton, S.K., In prep.[1]) provides general guidance on how to minimize impacts from drainage works to Grass Pickerel and its habitat. The following section is a direct excerpt from this document:

Basic Principles to Minimize Impacts of Drainage Works on Grass Pickerel

In Ontario, Grass Pickerel spawn from late March to early May with a period of approximately two to five weeks between spawning and the initiation of feeding by young. Spawning appears to be associated with flooded vegetation at temperatures ranging from 4°C to 12°C.

Municipal drainage activities (e.g., drainage maintenance, improvements and new drainage works) are a major threat to Grass Pickerel in Canada. Drainage typically involves channelization, which is the straightening and deepening of a channel, dredging, the removal of in-stream material (including most if not all structure/cover) and, often times, the destruction of riparian vegetation. In general, activities such as channelization and dredging, will have more of an impact than point-impact projects, such as road crossings.

The following interim guidance on drainage activities has been provided to minimize impacts to Grass Pickerel habitat; where possible, design considerations should seek to:

- Ensure floodplain connection is maintained - flooded vegetation must remain wet for ~5 weeks to support eggs and larvae within known or suspected Grass Pickerel spawning habitats. Projects should minimize impacts to the duration and extent to which floodplains are inundated
- Avoid projects within Grass Pickerel habitat during the spawning/hatching period (from mid-March to the end of May)
- Incorporate natural channel design principles to recreate habitat complexity
- Maintain pool habitats that act as overwintering and summer refugia
- Encourage 'spot clean-outs' to minimize maintenance footprint

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- Control sedimentation before, during, and after work to maintain clear water conditions
- Where vegetation is impacted, re-establish or enhance vegetative buffers along the channel.

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Table 1. Threats to the Grass Pickerel and potentially relevant Pathways of Effects.

Threats to the Grass Pickerel	Pathways of Effects
Low water levels	• Placement of material or structures in water • Water extraction • Dredging • Change in timing, duration, or frequency of flow
Loss of aquatic vegetation	• Vegetation clearing • Riparian planting • Streamside livestock grazing • Placement of material or structures in water • Dredging • Addition or removal of aquatic vegetation • Change in timing, duration, or frequency of flow
Decreased water transparency and general degradation of water quality	• Grading • Excavation • Use of industrial equipment • Cleaning or maintenance of bridges or other structures • Riparian planting • Streamside livestock grazing • Placement of material or structures in water • Dredging • Organic debris management • Wastewater management • Addition or removal of aquatic vegetation • Change in timing, duration, or frequency of flow • Structure removal
Lowering of stream temperatures	• Excavation • Riparian planting • Addition or removal of aquatic vegetation
Fragmentation of habitat (barriers to fish movement)	• Placement of material or structures in water • Dredging • Change in timing, duration, or frequency of flow • Fish passage issues
Loss of still-water habitats	• Dredging • Placement of material or structures in water • Change in timing, duration, or frequency of flow • Structure removal

Photo credit: Konrad Schmidt.

Figure 1. Grass Pickerel.

Photo credit: DFO 2009.

Figure 2. Grass Pickerel habitat in southern Ontario.

Photo credit: DFO 2009.

Figure 3. Grass Pickerel habitat in southern Ontario.

Photo credit: J. Barnucz DFO 2009.

Figure 4. Grass Pickerel habitat in southern Ontario.

Photo credit: G. Coker 2009.

Figure 5. Grass Pickerel habitat in southern Ontario, April 16, 2009.

(Note that the vegetated habitat was observed to be continuously flooded for a minimum of one month.)

Photo credit: G. Coker 2009.

Figure 6. Grass Pickerel habitat in southern Ontario, April 29, 2009.

(Note that the vegetated habitat was observed to be continuously flooded for a minimum of one month.)