Federal Docket No. FWS-R3-ES-2018-0110

90-DAY FINDING ON A PETITION TO LIST U.S. POPULATIONS OF LAKE STURGEON (*ACIPENSER FULVESCENS*) AS ENDANGERED OR THREATENED UNDER THE ENDANGERED SPECIES ACT

Petitioned action being requested:

☒ List as an Endangered or a Threatened species
☐Reclassify (uplist) from a Threatened to an Endangered species

Petitioned entity:

- ☒Species
- ☐ Subspecies
- ☐ DPS of vertebrates
- ☒ Subset of listed entity (species, subspecies, DPS, etc.)

Lake sturgeon rangewide

Lake sturgeon petitioned DPSs:
- Lake Superior
- Western Lake Michigan
- Red River
- Rainy Lake/Rainy River/Lake of the Woods
- Upper Mississippi River
- Missouri River
- Ohio River
- Arkansas-White River
- Lower Mississippi River

Background

Section 4(b)(3)(A) of the Endangered Species Act (Act) requires that we make a finding on whether a petition to list, delist, or reclassify a species presents substantial scientific or commercial information indicating that the petitioned action may be warranted. Our standard for substantial scientific or commercial information within the Code of Federal Regulations (CFR) with regard to a 90-day petition finding is "that amount of information that would lead a reasonable person to believe that the measure proposed in the petition may be warranted" (50 CFR 424.14(b)).

Petition History

On May 23, 2018, we received a petition dated May 14, 2018, from the Center for Biological Diversity, requesting that lake sturgeon be listed as threatened or endangered and critical habitat be designated for this species under the Act. The petition clearly identified itself as such and included the requisite identification information for the petitioner, required at 50 CFR 424.14(c). This finding addresses the petition.

Evaluation of a Petition to List the Lake Sturgeon Under the Endangered Species Act

Species and Range

Does the petition identify an entity that may be eligible for listing (i.e., is the entity a species, subspecies, or DPS)?

☒ Yes
☐ No

The petition requests that we list the lake sturgeon as threatened rangewide or alternatively consider several DPSs as threatened or endangered.

Lake Sturgeon (*Acipenser fulvescens*)

Historical Range: Great Lakes, St. Lawrence, Hudson Bay, and Mississippi River basins in: Alabama, Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Nebraska, New York, North Carolina, North Dakota, Ohio, Pennsylvania, South Dakota, Tennessee, Vermont, West Virginia, and Wisconsin; Coosa River in Alabama and Georgia

Current Range: Great Lakes, St. Lawrence, Hudson Bay, and Mississippi River basins in: Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, New York, North Dakota, Ohio, Pennsylvania, Tennessee, Vermont, and Wisconsin; Coosa River in Alabama and Georgia

Petitioned DPSs:

Lake Sturgeon (population of *Acipenser fulvescens*); Lake Superior (Michigan, Minnesota, Wisconsin)

Lake Sturgeon (population of *Acipenser fulvescens*); Western Lake Michigan (Wisconsin)

Lake Sturgeon (population of *Acipenser fulvescens*); Red River Basin (Minnesota, North Dakota)

Lake Sturgeon (population of *Acipenser fulvescens*); Rainy Lake/Rainy River/Lake of the Woods (Minnesota)

Lake Sturgeon (population of *Acipenser fulvescens*); Upper Mississippi River Basin (Illinois, Iowa, Minnesota, Wisconsin)

Lake Sturgeon (population of *Acipenser fulvescens*); Missouri River Basin (Kansas, Missouri, Nebraska, South Dakota)

Lake Sturgeon (population of *Acipenser fulvescens*); Ohio River Basin (Alabama, Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Tennessee, West Virginia)

Lake Sturgeon (population of *Acipenser fulvescens*); Arkansas-White River (Arkansas, Colorado, Kansas, Missouri, Oklahoma)

Lake Sturgeon (population of *Acipenser fulvescens*); Lower Mississippi River Basin (Arkansas, Louisiana, Mississippi, Missouri, and Tennessee)

To interpret and implement the DPS provisions of the Act, the Service and the National Oceanic and Atmospheric Administration published the Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act in the Federal Register on February 7, 1996 (61 FR 4722). Under the DPS Policy, three elements are considered in the decision regarding the establishment and classification of a population of a vertebrate species as a possible DPS: (1) The discreteness of a population segment in relation to the remainder of the species to which it belongs; (2) the significance of the population segment to the species to which it belongs; and (3) the population segment's conservation status in relation to the Act's standards for listing, delisting, or reclassification. Both discreteness and significance are used to determine whether the population segment constitutes a valid DPS. If it does, then the population segment's conservation status is used to consider whether that DPS warrants listing. We address these elements with respect to the potential lake sturgeon DPSs identified in the petition.

Discreteness and Significance

Discreteness

Under the DPS policy, a population segment of a vertebrate species may be considered discrete if it satisfies either one of the following conditions: (1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors (quantitative measures of genetic or morphological discontinuity may provide evidence of this separation); or (2) it is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

Significance

Under the DPS policy, a discrete population segment of a vertebrate species may be considered significant if there is: (1) Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon; (2) evidence that loss of the discrete population segment would result in a significant gap in the range of the taxon; (3) evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range; or (4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

<u>Lake Superior</u>

Discreteness

The petitioner asserts that lake sturgeon in Lake Superior and its tributaries are physically separated from other lake sturgeon populations. The Lake Superior population is not physically isolated from the rest of the Great Lakes basin as described in the petition. However, most Lake Superior lake sturgeon populations are genetically or reproductively distinct from other Great Lakes populations (DeHaan et al. 2006, p. 1487; Homola et al. 2010, p. 801; Welsh et al. 2010, pp. 17, 23).

Significance

The petitioner asserts that the Lake Superior population is ecologically significant because it occupies the largest body of freshwater in the world and a major portion of the lake sturgeon range in the Great Lakes. Loss of this population may leave a significant gap in the range of the species.

Western Lake Michigan

Discreteness

The petitioner asserts that lake sturgeon in western Lake Michigan are reproductively isolated from other lake sturgeon populations in the Great Lakes. Genetic data support that the Western Lake Michigan lake sturgeon population is reproductively separate from the eastern Lake Michigan population and other populations within the Great Lakes basin (Welsh et al. 2010), but are not physically isolated (i.e., no physical barriers separate the populations).

Significance

Welsh et al. (2010, p. 23) defined six distinct genetic stocking units across the Great Lakes basin, which included Green Bay. The petition's description of western Lake Michigan is consistent and synonymous with the Green Bay grouping described in Welsh et al. (2010, pp. 17, 23) and with genetic population structure described in Homola et al. (2010). Loss of this population may represent a significant loss to the genetic diversity of the lake sturgeon across its range.

Red River

Discreteness

The Red River watershed is bisected by an international (Canada-U.S.) governmental border between Manitoba, Canada and Minnesota and North Dakota. The petitioner asserts that lake sturgeon in the Red River basin are discrete because of their geographical isolation as well as differences in conservation status of lake sturgeon and control of exploitation on either side of the international border. The petitioner claims that Manitoba allows only catch-and-release angling for lake sturgeon (citing MBDNR 2012), whereas Minnesota allows anglers, with certain conditions, to harvest one lake sturgeon per year from Minnesota-Canada border waters (citing MNDNR 2016). Within the Canada-Minnesota border waters, Minnesota has a catch-and-release fishery, two harvest seasons with a limit of one lake sturgeon per year, and a spawning season closure (MNDNR 2018, p. 58). Although COSEWIC (2006, p. 77) identifies the Red-Assiniboine Rivers-Lake Winnipeg populations of lake sturgeon (Designatable Unit (DU) 4) as endangered, lake sturgeon are not federally protected in Canada under the Species at Risk Act (SARA) or under the Manitoba Endangered Species Act (MBDNR 2012, p. 14). The State of Minnesota lists lake sturgeon as "special concern".

Significance

The petitioner asserts that this population differs markedly in its genetic characteristics from all other populations. Citing COSEWIC (2006), the petitioner claims that lake sturgeon in Red-Assiniboine Rivers/Lake Winnipeg, which includes the Red River basin, are genetically distinct from other drainages and populations. Information in our files indicates the Red River population is a reintroduced population, using Rainy River strain.

Rainy Lake/Rainy River/Lake of the Woods

The Rainy Lake/Rainy River/Lake of the Woods watershed is bisected by an international (Canada-U.S.) governmental border between Ontario, Canada and Minnesota. The petitioner asserts that lake sturgeon in Rainy Lake/Rainy River/Lake of the Woods are discrete due to their geographical isolation as well as differences in the conservation status of lake sturgeon and control of exploitation on either side of the international border. COSEWIC (2006, p. 81) identifies the Lake of the Woods-Rainy River populations of lake sturgeon (DU 6) as special concern. Ontario has a year-round "closed" recreational sturgeon fishery within the border waters with Minnesota (OMNRF 2018), and Minnesota has a catch-and-release fishery and allows anglers, with certain conditions, to harvest one lake sturgeon per year from Minnesota-Canada border waters (MNDNR 2018, p. 58).

Significance

The petitioner asserts that this population differs markedly in its genetic characteristics from all other populations (COSEWIC 2006, p. 9). Genetic studies confirm that the Rainy River sturgeon is genetically distinct from other drainages and the Hudson Bay populations, including the Winnipeg River population (COSEWIC 2006, pp. 8, 12), possibly by natural falls and rapids prior to construction of dams and hydroelectric facilities (COSEWIC 2006, p. 16). However, there is a lack of genetic information from waters upstream of Rainy River/Rainy Lake.

Upper Mississippi River

Discreteness

The petitioner asserts that lake sturgeon in the upper Mississippi River basin are geographically isolated from all other lake sturgeon populations. There are naturally spawning remnant populations in the Kettle, Snake and Upper St. Croix rivers (Dieterman et al. 2010, p. 339) and possibly several tributaries in Wisconsin, including Chippewa River. Genetic studies found upper Mississippi River sturgeon to be significantly differentiated from sturgeon within Ohio River (Drauch et al. 2008, p. 1204). A nearly complete to complete barrier at Lock & Dam (L&D) 19 may minimize interaction of sturgeon downriver of L&D 19 from sturgeon upriver of the L&D. Prior to construction of the L&D at Keokuk in 1957, a large rapids was present that may have separated lake sturgeon. In review of lake sturgeon movements from on-going telemetry studies by the Missouri Department of Conservation and Minnesota Department of Natural Resources (DNR), other dams may be barriers to movement or influence the behavior of lake sturgeon.

Significance

The petitioner asserts that loss of lake sturgeon from the upper Mississippi River basin would result in a significant gap in the range of lake sturgeon. The Upper Mississippi River population encompasses several remnant subpopulations from St. Croix (Minnesota and Wisconsin) and Wisconsin river tributaries. This population may be an important source of sturgeon for populating the Upper Mississippi River if there were a catastrophic event on the Mississippi

River. Loss of these Minnesota-Wisconsin tributary populations may leave a significant gap in the range of the species.

Missouri River

Discreteness

The petitioner asserts that lake sturgeon in Missouri River are geographically isolated from all other lake sturgeon populations. A lower Missouri River lake sturgeon population is present and is not physically isolated from other lake sturgeon in the lower Missouri River basin and the Mississippi River. Hatchery-produced lake sturgeon have been stocked in the Missouri and Mississippi rivers in Missouri from various upper Mississippi River drainage lineages and initial 1984 stockings of the Lake Winnebago (Great Lakes) strain (MDC 2018). Wild fish collected on the Missouri River are rare, and if found may be large adults considered to have migrated from the upper Mississippi River. The lower Missouri River and the middle Mississippi are not geographically isolated. Recent telemetry studies show that lake sturgeon move through some of the Mississippi River Lock and Dams below L&D 19 with one documented spawning event below L&D 26 (Mel Price Dam) between Missouri River and Mississippi River tagged sturgeon (Buszkiewicz et al. 2016, p. 1022). We find that the petition does not present substantial information that the Missouri River DPS may be discrete under our DPS policy.

Ohio River

Discreteness

The petitioner asserts that lake sturgeon in the Ohio River basin are geographically isolated from all other lake sturgeon populations. The East Fork White River population (Wabash River tributary) is the only surviving, naturally reproducing population indigenous to the Ohio River drainage. The population likely escaped harvest and severe habitat destruction due to its location within the rural landscape of Indiana (Drauch et al. 2008, p. 1204) at the time. Rising numbers of lake sturgeon over time from the Missouri Department of Conservation stocking efforts in the Middle Mississippi and lower Missouri rivers have increased the geographical movement to the lower Mississippi and Ohio rivers, increasing the potential to interact with the White River population. However, lake sturgeon in the Ohio River basin remain reproductively separate from other lake sturgeon populations.

Significance

The petitioner asserts that the East Fork White River population is the only known remaining population in the Ohio River drainage and represents a genetically unique remnant stock (Drauch et al. 2008, p. 1196). The population is genetically distinct from sturgeon tested from the Upper Mississippi River, Great Lakes, and Hudson Bay drainages. The loss of this population may leave a significant gap in the range of the species. The East Fork White River remnant population in Indiana may be crucial as a source population for the long-term success of populating the Ohio River basin (Drauch et al. 2008, p. 1196). Lake sturgeon are being reintroduced into the Cumberland and Tennessee River systems in Tennessee and Kentucky with sources from outside the watershed (SLSWG 2014, p. 24).

Arkansas-White River

Discreteness

The petitioner asserts that lake sturgeon in the Arkansas-White River basin are geographically isolated, if still occurring there. Based on the historical range of the species, this basin is likely peripheral. Despite extensive sampling on a regular basis, there are few records of lake sturgeon in this river system (USFWS 2018a).

Significance

The petitioner asserts that lake sturgeon in other major sub-basins of the Mississippi River (upper Mississippi River and Ohio River) are genetically distinct (Drauch et al. 2008, p. 1204), suggesting that there may also be evolutionary independence for any naturally occurring lake sturgeon from the Arkansas-White River basin.

<u>Lower Mississippi River</u>

Discreteness

The petitioner asserts that lake sturgeon in the lower Mississippi River basin, if still present, are geographically isolated from all other lake sturgeon populations. There are few records of lake sturgeon in the lower basin. Increases in stocked lake sturgeon from Mississippi River Pool 24 and the lower Missouri River by the Missouri Department of Conservation will allow fish to move further down river within the lower Mississippi. Based on the historical range of the species downriver of Missouri, the Lower Mississippi population would be considered peripheral. Extensive sampling on a regular basis has captured few records of lake sturgeon in the lower river (Lower Mississippi River and Baton Rouge Fish and Wildlife Conservation Offices 2018).

Species Background

Lake sturgeon is a long-lived species that has a life strategy of slow growth and late maturation. Lake sturgeon can attain a length of 8 feet or greater and can live up to 150 years. Males typically reach sexual maturity about 14–16 years of age and about 45 inches in length and females at 24–26 years of age and about 55 inches in length, depending on the region.

Lake sturgeon is a periodic spawner, with males spawning every other year (Etnier and Starnes 1993, p. 99) or one to three years while females may spawn once every four to six years (WDNR 2000, p. 10). Some lake sturgeon are known to make long spring migrations, exceeding 300 miles to spawn while others make shorter, more localized migrations. Lake sturgeon spawn in clear rivers below natural falls, rapids, tailraces below dams if migration is blocked, or other areas where current is swift with coarse gravel, cobble, boulder and sand substrates (WDNR 2000, p. 11). In lakes, rocky shoals and shorelines may be utilized for spawning habitat. Spawning usually occurs from April through June depending on the region and is dependent on water temperature and flows. Spawning lake sturgeon congregate in groups in shallow water where multiple spawning events occur over a period of hours until the female expends all her eggs. Females have a high fecundity and may produce 50,000–885,000 eggs (Scott and Crossman 1973, p. 85; Priegel and Wirth 1974), depositing eggs in batches over multiple spawning events.

The early life stages of lake sturgeon are very sensitive and vulnerable to anthropogenic factors. Eggs are adhesive and are deposited in rocky areas where water current keeps the eggs oxygenated and free of silt. Sturgeon spawn at temperatures ranging from 8° C and 21° C (Becker 1983, p. 221; Bruch and Binkowski 2002, p. 573), with eggs hatching within 5–8 days before hatch (Scott and Crossman 1973, pp. 84–85; Becker 1983, p. 222). Larvae tend to hide in rocky crevices during the day and drift in the upper 1.3 feet of the water column at night to suitable nursery habitat (Kempinger 1988, p. 121). Lake Sturgeon yolk-sac larvae typically drift down river from approximately 7–16 miles, but can drift down river upwards of 38 miles (Auer and Baker 2002, p. 564; Smith and King 2005, p. 1164; Benson et al. 2005, pp. 1406–1408). Larvae and young lake sturgeon feed on minute crustaceans until 7–8 inches in length. Their diet shifts as larger juveniles and adult lake sturgeon prey on benthic organisms such as crayfish, mollusks, leeches, insect larvae like midges and small fish (Harkness and Dymond 1961) including round goby and sculpin (NYSDEC 2018, p. 5).

Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species is an "endangered species" or a "threatened species." The Act defines an endangered species as a species that is "in danger of extinction throughout all or a significant portion of its range," and a threatened species as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Act requires that we determine whether any species is an "endangered species" or a "threatened species" because of any of the following factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;
(B) Overutilization for commercial, recreational, scientific, or educational purposes;
(C) Disease or predation;
(D) The inadequacy of existing regulatory mechanisms; or
(E) Other natural or manmade factors affecting its continued existence.

These factors represent broad categories of natural or human-caused actions or conditions that could have an effect on a species' continued existence. In evaluating these actions and conditions, we look for those that may have a negative effect on individuals of the species, as well as other actions or conditions that may ameliorate any negative effects or may have positive effects.

We use the term "threat" to refer in general to actions or conditions that may be, or are reasonably likely to negatively affect, individuals of a species. The term "threat" includes actions or conditions that have a direct impact on individuals (direct impacts), as well as those that affect individuals through alteration of their habitat or required resources (stressors). The term "threat" may encompass—either together or separately—the source of the action or condition or the action or condition itself.

However, the mere identification of any threat(s) does not necessarily mean that the species may meet the statutory definition of an "endangered species" or a "threatened species." In determining whether a species may meet either definition, we must evaluate all identified threats by considering the expected response by the species, and the effects of the threats—in light of those actions and conditions that will ameliorate the threats—on an individual, population, and species level.

Information in the Petition

Factor A–Present or threatened destruction, modification or curtailment of the species habitat or range

1. Does the petitioner claim the entity warrants listing because of the present or threatened destruction, modification or curtailment of the species habitat or range?
   ☒ Yes
   ☐No

   a. If the answer to 1 is yes:
      Identify the activities that the petitioner claims result(s) in present or threatened destruction, modification or curtailment of the species habitat or range such that listing may be warranted.

      - Dams and hydroelectric facilities
      - Persistent bioacummulative and toxic chemicals
      - Lampricides
      - Pulp and paper industry
      - Crude oil transportation
      - Agricultural contaminants
      - Mining
      - Dredging and channelization

   b. If the answer to 1 is yes:
      Do the sources cited in the petition provide substantial information to support the claim? Include consideration of existing regulatory mechanisms or conservation efforts identified in the petition or from other readily available information that may ameliorate the threats.
      ☒ Yes
      ☒ No

Dams and Hydroelectric Facilities

Citing multiple sources (Harkness and Dymond 1961; Priegel and Wirth 1974, p. 12; Auer 1996, p. 155; Beamesderfer and Farr 1997, p. 409; Auer 2003, p. 4; Wilson and McKinley 2004, p. 67; COSEWIC 2006, pp. 8, 18; Peterson et al. 2007, p. 59; Pratt 2008, pp. 28, 30; Kerr et al. 2011, pp. 4–8), the petitioner claims that dams, including hydroelectric facilities, fragment habitat; alter river flows, water levels, water temperatures, and sediment transport; block migration to spawning grounds; and degrade habitat or cause habitat loss, negatively impacting sturgeon populations through impacts to spawning, feeding, and survival of early life stages and recruitment. Dams can produce reservoirs with greatly reduced flow that may not provide habitat necessary for larval lake sturgeon to survive, and multiple dams on a river can restrict riverine reaches to lengths too short for larval drift and development (Auer and Baker 2002, p. 563;

Smith and King 2005, p. 1169; Kynard et al. 2007; Braaten et al. 2008, p. 823), affecting survival and recruitment to the population.

Lake Superior

The petitioner claims Victoria Dam on Ontonagon River and Prickett Dam on Sturgeon River block lake sturgeon access to historic spawning grounds 8 kilometers (km) (5 miles (mi)) and 69 km (42.9 mi) upstream from Lake Superior, respectively (Auer 1996, p.) and that water temperature changes at Bond Falls and Prickett Dam have been detrimental to lake sturgeon (MIDNR 1994). Victoria Dam is located at a natural falls approximately 42 km (26.1 mi) from Lake Superior, not 8 km from Lake Superior as stated in petition. Timing of dramatic water temperature changes reported at Bond Falls likely occurs after the critical spawning/egg hatch life stage when summer temperatures increase surface water and bottom draw from Bond Falls is released. Additionally, there is no evidence of Lake Sturgeon spawning in East Branch Ontonagon River to be impacted by Bond Falls operation. Prickett Dam on Sturgeon River is located at or within 8 km (5 mi) of historic upper migration limit. Most Lake Superior hydropower facilities are now operated as run-of-the river (exception at White (Bad River)) and are located at or near the historic migration limits with suitable spawning habitat that exists downstream. Historic hydropower facility operations dramatically impacted lake sturgeon populations, but most impacts have been corrected (e.g., flow regimes).

Western and Eastern Lake Michigan

Citing multiple sources (Baker 1980; Bassett 1981; MIDNR 1994; Auer 1996; Thuemler 1997; Wesley and Duffy 1999; Runstrom et al. 2002; Galarowicz 2003; Peterson and Vecsei 2004; Elliott and Gunderman 2008; Daugherty et al. 2009; Caroffino et al. 2010; Coscarelli et al. 2011; Brunner and Alexander 2013; Wieten 2013), the petitioner claims that dams on Manistique, Indian, Peshtigo, Oconto, Fox, Wolf, Milwaukee, Escanaba, St. Joseph, Kalamazoo, Muskegon, and Manistee rivers block lake sturgeon access to spawning grounds. Although these dams likely contributed to the species' range-wide declines 100 years ago and extirpation from some river systems, populations that remain in most rivers of Lake Michigan, though low in abundance compared to historic levels, are currently stable or increasing in abundance despite their restricted range (MIDNR 2018, pp. 4–6; WDNR 2018a, pp. 4–6). Fish passage is also now provided on the lower Menominee River, dams have been removed on the Milwaukee River, and habitat has been created on the Kalamazoo River. Some populations are considered large and healthy, including the Lake Winnebago population, which is not threatened by dams. Threats associated with flow alterations have been addressed in most rivers in the basin over the past two decades. Barriers remain in only a few rivers listed in the petition and the associated altered flow regimes are likely a threat to the population in that river system.

Red River

The petitioner claims the remaining flood control, hydroelectric and other lowhead dams within the Red River basin may be the greatest threat to the recovery (self-sustaining) and stability of this population. Seven of the eight low-head dams have now been modified to allow for fish passage, with Christine and Hickson dam conversions completed in 2011 (MNDNR et. al. 2017, p. 5). Only the U.S. dam at Drayton, North Dakota remains. State natural resource agencies from Minnesota, North Dakota, and South Dakota, U.S. Fish and Wildlife Service, White Earth and partners agreed in the early 1990s that addressing connectivity was vital to the recovery of lake sturgeon in the Red River basin (MNDNR et al. 2002) and should be concurrent with stockings. Dams on major rivers within the basin block movements from the Red River mainstem to higher gradient tributaries historically used for spawning. Many of the dams were constructed at the base of hard outcrops like bedrock, natural falls or rapids with shallow, fast-moving water where spawning activities occurred (Aadland et al. 2005, p. 2) and inundated or flooded these natural rapids. Dams on the Buffalo and Otter Tail-Pelican River system currently alter flows and water levels, and inhibit upstream/downstream movements of lake sturgeon. As the population matures in 4-6 years, dams may impede movement to potentially optimal habitat needed for future spawning and disrupt downstream drift of larvae or restrict drift in riverine reaches to lengths too short for larval development (Auer and Baker 2002, p. 563; Smith and King 2005, p. 1169; Kynard et al. 2007; Braaten et al. 2008, p. 823). Some of the hydroelectric dams on Ottertail River have created deep reservoirs that have greatly reduced flow and may not provide habitat necessary for larval and young lake sturgeon to survive. The Minnesota DNR, FWS, counties, and others have made great progress in the removal and modification of barriers on the mainstem and its tributaries such as Sandhill, Buffalo, Wild Rice, and Otter Tail rivers (Aadland 2010, pp. 116-118, 120, 126, 140–166).

The petitioner claims that a proposed diversion channel on the Red River mainstem threatens the Red River population. The diversion channel is 36-miles long and crosses several tributaries, including Wild Rice River a 120-mile long major sturgeon tributary containing no dams. A supplemental EIS was completed at the request of the Minnesota DNR, design revisions for the diversion project were made and approved and state and federal permitting is in progress. The floodway is proposed to start operating at a minimum of a 100-yr flood event in which water would be diverted out of the main channel. The diversion project encompasses some agreed upon mitigation for habitat alteration. Partial mitigation includes modification of Drayton Dam to provide fish passage; however, upstream/downstream movement by lake sturgeon on the Red River mainstem, river flows and access to the Wild Rice and other tributaries when the diversion is in operation may be a concern.

Rainy Lake/Rainy River/Lake of the Woods

The petitioner claims dam construction threatens the Lake of the Woods/Rainy River lake sturgeon population. Rainy Lake sturgeon have been separated from Lake of the Woods/Rainy River sturgeon by dams since the turn of the 20th century. Despite presence of several dams fragmenting the system, habitat seems to be adequate to accommodate all life stages of lake sturgeon, as the population is self-sustaining with close monitoring of the recreational fishery. This area is jointly managed by Canada and Minnesota to include joint management of water levels from dam operations.

Upper Mississippi River

The petitioner claims that dams without locks within the Mississippi River basin completely block sturgeon passage and are severe impediments to lake sturgeon recovery (St. Pierre and Runstrom 2004). Tributary dams and hydroelectric developments on the Chippewa, Manitowish, Namekagon, and Wisconsin rivers fragment river reaches consisting of habitats utilized for a range of life stages. These dams may fragment gene flow, alter river flows and river levels, impede migration upstream to historic spawning grounds, and depending on the reach and habitat may disrupt downstream drift of sturgeon larvae, likely increasing the mortality from drifting over dams and caught in the recirculating current.

In Iowa, lake sturgeon have generally been excluded from interior rivers because of dams (IADNR 2018). Flood control, hydroelectric and other dams prevent lake sturgeon from moving primarily beyond first dams from the Mississippi River. There have been a few reports in the state of Iowa natural area inventory database of lake sturgeon captures. Several captures have been made below the first dam at Ottumwa on the Des Moines River and the Palisades Dam on the Cedar River. There is anecdotal evidence for limited occurrence of lake sturgeon on higher gradient rivers like the Maquoketa and Upper Iowa rivers (IADNR 2018) in the northeast part of the state.

A few small populations may persist within the St. Croix watershed, but the stability of these populations within the tributaries and the St. Croix is not clear. There is evidence that some dams are passable, and reaches within the St. Croix, Kettle, and Snake rivers have high quality spawning habitat connected to lakes and deep pools that may provide adult refugia and habitat from drought and winter conditions (Aadland et al. 2015, p. 13). However, sturgeon may be isolated from each other by other dams. A water control structure on the Danbury Flowage on Yellow River serves as a barrier to fish movement from St. Croix River and has isolated the Yellow Lake sturgeon from the St. Croix River sturgeon since the 1930s (Johannes 1988).

Missouri River

The Osage River in Missouri has a small population that was reported to have exhibited pre-spawning/spawning behavior in 2014 (MDC 2018, p. 14). Wide fluctuations in water releases from Bagnell Dam (hydroelectric dam) can change flows, velocities and river stage within a very short period of time, negatively impacting and possibly prohibiting successful lake sturgeon spawning in the river (MDC 2018, p. 14). Fish stocked on Missouri River by the Missouri Department of Conservation have been captured in Nebraska's eastern border by the Nebraska Parks and Game Commission (Steffensen et al. 2014, p. 42). As stocked sturgeon expand their distribution upriver on the Missouri River, barriers may limit use of major tributaries like the Platte and Kansas rivers that were once utilized by lake sturgeon.

Ohio River

The petitioner claims that navigation dams in the Ohio River rendered most of the basin's habitat unsuitable for lake sturgeon (Trautman 1981). The remnant East Fork White River lake sturgeon population has been reported to make annual upstream spawning runs until further movement is blocked by Williams Dam (INDNR 2012, p. 11). Spawning activities have occurred below Williams Dam, and there have been signs of reproductive success since 2005. In the Cumberland and Tennessee Rivers of the Ohio basin, a vigorous and scientific restoration program is ongoing.

Arkansas-White River

The petitioner claims that 10 hydroelectric facilities have been proposed on Arkansas River since 2011. We do not have readily available information in our files about this population.

Lower Mississippi River

The major threat recognized on the lower Mississippi River is hydrokinetics of which 55 projects have been proposed since 2011. Based on our knowledge of hydrokinetics and from testimony provided by leaders within the industry to the Mississippi River Commission, hydrokinetics projects may be continue to be pursued elsewhere at existing dams (USFWS 2018a).

Measures to curtail dam and hydropower dam impacts can include enacting minimum flow requirements at hydroelectric facilities, reduce peaking by implementing run-of the river operations, and provide hydrological connectivity and fish passage to reduce habitat fragmentation. Lake sturgeon may spawn at the base of dams if rocky substrate is available when prevented from further migration (Kempinger 1988; Auer 1996, 1999). Some mitigation measures have included constructing artificial spawning substrate below hydroelectric dams instead of providing fish passage or placing rip rap or gravel substrate along river corridors. This measure has had success in some river systems. Artificial spawning rocky structures placed at the proper depth and current velocity with adequate surface area and appropriate substrate size for lake sturgeon has been successful in the St. Lawrence, Detroit, and Des Prairies rivers (Johnson et al. 2006; Roseman et al. 2011, p. 465; Dumont et al. 2011, p. 10) and other sites. Long-term maintenance is needed to keep spawning habitat free of algae, sediment and other material (Johnson et al. 2006).

Persistent Bioaccumulative and Toxic Chemicals

The petitioner claims that pollutants, such as heavy metals, PCBs, mercury, and industrial waste, that have entered waterways intentionally or accidentally from manufacturing and industrial plants have contributed to declines in lake sturgeon. The petitioner stresses that PCBs are worrisome because they are long-lasting in the environment and are linked to declines in lake sturgeon populations in several rivers in which the contaminants affected various life stages and cite sources for Fox River (citing Gunderman and Elliott 2004, p. 32), St. Clair River (citing COSEWIC 2006, p. 64) and Green Bay and Menominee River (citing Hay-Chmielewski and Whelan 1997, p. 39). In addition, a recent study in which lake sturgeon embryos and fry were exposed to varying levels of PCBs and dioxins in the laboratory demonstrated that these compounds can cause significant abnormalities affecting development and survival and that lake sturgeon are more sensitive to the effects of these compounds than most other species of fish, including both shovelnose and pallid sturgeon (Tillitt et al. 2017). PCBs and dioxins, as lipophilic compounds, are found in the greatest concentrations in the environment associated with sediments where lake sturgeon feed and in lipid-rich tissues of aquatic organisms, including the eggs of fish. Lake sturgeon with their long life spans, can accumulate significant concentrations of these contaminants. These contaminants in female fish tissues are readily transferred to eggs as lipids and are deposited there during development and can thus have effects on reproduction and larval survival and development, as well as potentially impacting the growth and development of juveniles and subadults and health of adults if concentrations are great enough. While few data are available on the concentrations of these compounds in lake sturgeon or their eggs, the available data indicate that the concentrations tested by Tillitt et al. (2017) are environmentally relevant and that it is possible that these compounds have contributed to the decline of lake sturgeon in the Great Lakes.

The petitioner states that the Great Lakes is a net sink for mercury from coal-fired power plant emissions and that mercury entering waterways from manufacturing processes and the disposal of industrial and consumer products is problematic. The petitioner claims that mercury and methylmercury have negative effects on lake sturgeon (citing Feist et al. 2005, Webb et al. 2006; Lee et al. 2011). Webb et al. (2006, p. 450) found that methylmercury may have a negative effect on the reproductive potential of white sturgeon (*Acipenser transmontanus*). Lee et al. (2011, p. 233) found that methylmercury increased mortality and decreased growth rate in green sturgeon (*Acipenser medirostris*). However, the Feist et al. (2005) paper examined the relationship between adverse effects and exposure to PCBs and organochlorine pesticides in white sturgeon in the Columbia River and does not mention mercury or methyl mercury. The petitioner also asserts that almost all fish in the Great Lakes have dietary advisories due to high concentrations of mercury (Stamper et al. 2012). Stamper et al. (2012, p. 17) indicates that lake sturgeon in the Great Lakes exceed the recommended methylmercury reference dose for human consumption, but does not address effects of mercury on lake sturgeon.

Lampricides

The petitioner asserts that the lampricide TFM, used to control sea lampreys, may be a threat to lake sturgeon populations in the Great Lakes and other areas where sea lamprey are a problem. Smaller lake sturgeon are more sensitive to lampricides, with concentrations that produced 50% mortality in juvenile lake sturgeon at or near the minimum lethal concentrations required for effective control of larval sea lampreys (Boogaard et al. 2003, p. 533). Sakamoto et al. (2016, pp. 3465–3466) showed that TFM caused neurophysiological and behavioral changes in young lake sturgeon, reducing olfactory response to food cues and food consumption.

Although the petition presents substantial information that lampricides affect lake sturgeon, the petitioner also acknowledges that recommended changes to sea lamprey treatments (Hay-Chmielewski and Whelan 1997, p. 35) have mostly been implemented and should ensure that chemical treatments will not adversely affect lake sturgeon.

For example, TFM is also used with Bayluscide to reduce the amount of TFM needed in treatment areas. A granular form of Bayluscide can be used in areas of slow-moving or stationary waters where TFM is not as effective. Barriers, trap-and-sort fishways, and traps are other methods commonly used in the control of sea lamprey. Therefore, we find this information not to be substantial.

Pulp and Paper Industry

The petitioner claims that effluent discharge from pulp and paper mills into waterways are adversely affecting lake sturgeon. Historically, pulp and paper mills disposed of chemical effluent and wood fiber into the Great Lakes and tributaries, causing significant water quality problems contributing to declines in lake sturgeon (citing O'Neal 1997, p. 49–50; Gunderman and Elliot 2004, p. 33), and the petitioner states that as of 1996, 10 pulp and paper mills were discharging effluent into the Great Lakes and their tributaries (citing Commoner et al. 1996). Other sources listed were not readily available to confirm impacts. The petitioner states that 26 areas within the U.S. portion of the Great Lakes were identified by EPA for targeted clean-up of legacy contaminants. However, information in our files indicates these are not all related to the pulp and paper industry. The petitioner reports that Michigan is actively trying to minimize the use of chlorine and reduce emissions and discharge of mercury and other compounds in effluent, hazardous materials and waste (citing MPPEC and MDEQ 2000). Although the petition identifies multiple compounds in emissions from paper mills, the petitioner discusses only mercury and dioxins as concerns to lake sturgeon. We address the effects of mercury and dioxins above under Persistent Bioaccumulative and Toxic Chemicals.

Crude Oil Transport

The petitioner claims that increases in crude oil transport—conducted with little to no environmental review and lacking adequate spill response plans—have led to several train car derailments and the resulting oil spills have entered waterways, posing a significant risk to lake sturgeon rivers and habitats throughout the Midwest, including the Mississippi River and its tributaries and the Lake Michigan and Lake Superior basins (citing CBD 2015). The petitioner also asserts that the Line 5 Oil Pipeline threatens lake sturgeon habitat in the Lower and Upper peninsulas connecting Lake Michigan and Lake Huron due to the potential for an oil spill and the lack of an adequate response plan (citing NWF 2017), and the petitioner notes that a University of Michigan study estimated that a "worst-case discharge" from Line 5 would jeopardize more than 1,000 km of Lake Huron-Michigan shoreline and specific islands (citing Schwab 2016).

Schwab (2016) simulates how oil from potential spills from the Line 5 pipeline in the Straits of Mackinaw would move through the Great Lakes and shorelines. The other cited sources (CBD 2015; NWF 2017; Schnurr 2017) do not provide any information about specific past railroad spills in the basins, documentation that environmental reviews were not properly conducted or inadequate response plans remain in place, or impacts to lake sturgeon populations. The petitioner states that oil spills can affect several life stages of lake sturgeon by covering spawning and nursery substrates, affecting egg development and survival, and accumulating toxins in the macroinvertebrates upon which lake sturgeon feed but did not provide any citations.

The Department of Transportation is responsible for railroad transportation, and the federal agency has the responsibility to oversee and address the safety of railroad infrastructure and railroad cars, and spill response plans and has the authority to act upon compliance violations.

Agricultural Contaminants

Citing several sources (Pflieger 1975; Graham 1981; Mosindy 1987; NatureServe 2004; COSEWIC 2006, p. 65), the petitioner claims that nutrients from agricultural fertilizers have been shown to have an adverse impact on sturgeon populations. The petitioner also asserts that eutrophication, caused by excessive nutrients in water bodies, is a well-documented problem throughout the lake sturgeon's range, especially in the Great Lakes (citing Houston 1987; Heuvel and Edwards 1996; Madenjian et al. 2002; Bronte et al. 2003; COSEWIC 2006; Marsden and Langdon 2012; PNAS 2013), and manure and waste from domestic livestock feedlots also impacts water chemistry in streams (citing DFO 1992; COSEWIC 2006). We were unable to find or access all of the cited sources (NatureServe 2004; PNAS 2013; DFO 1992); however, none of the cited sources we could check (Pflieger 1975; Graham 1981; Mosindy 1987; COSEWIC 2006) directly link agricultural-related nutrient inputs in waterways to declines in lake sturgeon or threats to specific sturgeon populations.

Although fertilizer use has increased overall, as stated by the petitioner, it has spread over a much larger geographic area than a half-century ago. The average size of a farm in the U.S. has grown from 216 acres in 1950 to 461 acres in the 1990s (Spielmaker 2018). The petitioner states that algal blooms have caused oxygen-deprived dead zones in the Great Lakes-Lake Erie. In 2010, a partnership consisting of the agricultural industry, NGOs, academia, state and business organizations created the 4R Program—"Right source, Right rate, Right time, Right place"—to address the algal bloom problem. The program recognizes farmers that use sound nutrient stewardship practices when applying fertilizer. Because of the success of the program, it has since spread to 19 states. Producers that farm with this idea have significantly reduced nutrient waste and runoff into streams.

There are many on-going efforts to reduce nutrients entering waterways. Farmers are utilizing computers in their tractors (precision farming) to apply more or less fertilizer to crops depending on soil type and past yield outputs. Federal, state, and local government, fish habitat partnerships, NGOs, agricultural entities, foundations, etc., are working with farmers to improve agricultural best management practices such as nutrient management, tillage reduction, grassed waterways, terraces and buffers, cover crops, continuous perennial cover, riparian corridor and floodplain protection.

Mining

Citing Hay-Chmielewski and Whelan (1997, p. 37), the petitioner claims that excessive inflows of fine sediment and sand from mining activities have caused water quality and quantity problems in some sturgeon waterways in Michigan; however, no specific Michigan drainages were identified in the petition. The Oil, Gas and Minerals Division of the Michigan Department of Environmental Quality (MDEQ) regulates sand dune, coal, copper and metallic mining. Mining operation plans and reclamation plans are required in the state permitting process and activities need to be in compliance with both state and federal laws such as the Clean Water Act (CWA). Performance standards must be met and inspections and monitoring are required. In the MDEQ's review of mining activities, a restraining order, injunction or an appropriate remedy may be taken to prevent and preclude violation of the terms and conditions under Michigan's (state law) Natural Resources and Environmental Protection Act (MI NREPA Chapter 451–1994–III–3–4 part 361–367), and the local government has the authority to enforce these regulations.

The petitioner also claims that a history of iron ore and taconite mining have contaminated lake sturgeon habitat in St. Louis River in northeastern Minnesota; however, the petitioner did not cite any sources for this information. Taconite is low grade iron ore. During processing, the iron ore is separated from the taconite using magnetism and the remaining rock is waste material and is dumped into tailing basins or in the past, prior to the Clean Water Act, discharged directly into waterways. Clean up and habitat restoration efforts have been underway for decades and have made marked improvements in water quality and habitat. Lake sturgeon have been reintroduced into the St. Louis River and there is now evidence of spawning and identified nursery areas containing lake sturgeon fry. This recovering population is facing new threats from a future copper, nickel and precious metals mine by PolyMet Corporation. An EIS has been completed and permitting is moving forward by Minnesota DNR and U.S. Army Corps of Engineers.

There are regulatory mechanisms in place to minimize potential impacts to Minnesota waterways. The Minnesota DNR Lands and Minerals Division requires Environmental

Assessment Worksheets and/or Environmental Impact Statements for new mining proposals in Minnesota and are often required for expansions of existing operations (Minnesota statute-Rules part 4410.4300, subparts 11–12, and part 4410.4400). Certain requirements must be adhered to under permit, including annual inspections and submission of annual reports and operating plans. Standards are set for reclamation and authority in place to take actions when necessary.

Dredging and Channelization

Citing multiple sources, the petitioner claims that dredging and channelization activities have altered erosion and sedimentation processes, leading to failed recruitment in lake sturgeon (Khoroshko 1972; Parsley et al. 1993; Williot et al. 1997; Paragamian et al. 2001; Jager et al. 2002; Daugherty et al. 2008, p. 6), habitat degradation and loss of sturgeon spawning and nursery habitats (St. Pierre and Runstrom 2004) and smothering of larval sturgeon (Kerr et al. 2011, p. 11). The petitioner asserts these impacts to lake sturgeon populations are particularly severe in the Midwest and tributaries of Lake Erie, the Prairies, and Rainy River in northern Ontario (citing NatureServe 2004; COSEWIC 2006, p. 65). The Parsley et al. (1993), Paragamian et al. (2001), and Jager et al. (2002) papers studied white sturgeon (*Acipenser transmontanus*); and those papers, in addition to Daugherty et al. (2008), did not consider dredging or channelization effects. We were unable to access Khoroshko (1972) and Williot et al. (1997) to evaluate the claims made about limited or failed recruitment of lake sturgeon. However, Kerr et al. (2011, p. 12) provides information that dredging and channelization activities can remove spawning substrate, deposit sediment over spawning substrate, increase turbidity, reduce light penetration and may decrease dissolved oxygen levels limiting available spawning and juvenile habitat, egg and larvae development and recruitment.

Dredging activities are frequent in the navigation channels and harbors of Lake Erie in Ohio. Working with the U.S. Army Corps of Engineers and contractors on the timing of dredging activities may minimize effects on sturgeon such as turbidity in navigation channels that are likely used as travel corridors and at tributary-lake confluences where sturgeon may congregate in the spring or other habitat needed during the season. Dredged material as stated in Ohio's Dredging plan should be placed in an appropriate, designated place so there will be no harm to aquatic life. Efforts should also be made to return channelized river and stream reaches back to their natural diversity of habitats where possible. The Ohio Environmental Protection Agency is enacting revised Ohio Code chapter 611.32 Dredging rule in 2020. The rule states that dredge material from navigation channels and harbors can no longer be disposed of in the open waters of Lake Erie (Ohio Code chapter 611.32).

The petitioner also states that sturgeon selection of navigation channels as migratory pathways in channelized reaches is significantly higher than alternative pathways through less channelized river reaches, increasing vulnerability to injury and mortality from encounters with commercial ships (Hondorp et al. 2017) as well as recreational vessels. Injury and mortality may be a threat to lake sturgeon in Lake Erie and other waters where there is heavy commercial ship traffic.

Factor B–Overutilization for commercial, recreational, scientific, or educational purposes

2. Does the petitioner claim the entity warrants listing because of overutilization for

commercial, recreational, scientific, or educational purposes?

☒ Yes
☐ No

a. If the answer to 2 is yes:

Identify the purpose(s) for which the petitioner claims the entity is being overutilized such that listing may be warranted (check all that apply):

☒ Commercial
☒ Recreational
☐ Scientific
☐ Educational
☒ Other: [Illegal harvest and poaching; see Factor E]

b. If the answer to 2 is yes:

Do the sources cited in the petition provide substantial information to support the claim? Include consideration of existing regulatory mechanisms or conservation efforts identified in the petition or from other readily available information that may ameliorate the threats.

☐ Yes
☒ No

Commercial Fisheries

The petitioner states that none of the lake sturgeon populations have recovered from past commercial harvesting and some populations have been extirpated (NatureServe 2004). While acknowledging that commercial catch of lake sturgeon is now prohibited in all U.S. waters (Williamson 2003, p. 75), the petitioner asserts that legal trade in lake sturgeon flesh and caviar is allowed in Michigan, Minnesota, New York and Ohio, and trade in live lake sturgeon is permitted in all of these states except for Ohio (citing Bruch 1999; Williamson 2003, p. 170). However, the petitioner does not provide information about potential effects of trade on lake sturgeon populations.

Recreational Fishing

Lake Sturgeon Sport Fishery Harvest

Minnesota, Michigan and Wisconsin have a lake sturgeon sportfish harvest of one fish per calendar year on limited and specified river reaches and waterbodies. The natural resource agencies closely monitor these populations. Minnesota requires a tag and mail-in registration for harvest and possession in the Lake of the Woods/Rainy River, and Wisconsin and Michigan anglers must get a tag and register their fish within a 24-hr period. Quotas are set for some of the specified waters like Black Lake in Michigan, and the quota may or may not be reached within the 5-day fishing period. The information obtained from registrations and commitment to closely monitoring the fishable population is expected to help adaptively manage the fishery by changing regulations as needed. Strict bag limits, size, and length of season set by these natural resources agencies are meant to prevent depletion of stocks. Resources agencies have adjusted bag and length limits through adaptive management over the years as noted in the petition. For example, in the Lake Superior basin, minimum length limits have changed from 40 inches to 50 inches in 1992, and the Wisconsin DNR has initiated a process to move to a 60-inch length limit, recognizing increases in harvest in recent years (WDNR 2018a, p. 8). By increasing the limit, the DNR's expectation is that it will limit harvest and provide continued growth of the population. The natural resource agency has adjusted its regulations to protect small lake sturgeon populations in the Great Lakes. In 2000, the hook and line fishery in Peshtigo, Oconto and Fox rivers and Green Bay were closed to protect those small populations (WDNR 2018a, p. 8).

Lake Sturgeon Catch and Release

The petitioner claims sport fishing is of concern where lake sturgeon populations are small or the limits are not adequately protective. Kentucky, Michigan, Minnesota and Wisconsin have a catch and release lake sturgeon recreational fishery for some specified waters (KDFWR 2018, p. 3; MIDNR 2016; MNDNR 2018, WDNR 2018b). The petitioner stated that there is not good information on the potential impacts to lake sturgeon from catch and release fishing. We do not have other readily available information about the potential impacts to sturgeon populations resulting from a catch and release lake sturgeon sport fishery.

Misidentification and Inadvertent Harvest

The petitioner claims that there is a potential threat to lake sturgeon due to angler misidentification and inadvertent harvest in states that allow sport harvest of other sturgeon species, such as the shovelnose sturgeon, in waters where lake sturgeon also occur and asserts that lake sturgeon is the most likely Illinois endangered or threatened species of fish to be inadvertently taken by sport fishing (ILDNR 2016, p. 5). A shovelnose sturgeon recreational fishery exists in specified waters of Arkansas, Illinois, Indiana, Iowa, Minnesota, Missouri, Nebraska, and Wisconsin with some states having no minimum length limits and/or no bag limits. Varying size limits and states with no daily shovelnose sturgeon bag limits may increase the likelihood that a lake sturgeon will be caught and harvested inadvertently or illegally because of the growing number of stocked lake sturgeon in the upper and middle Mississippi and Missouri rivers.

Public outreach and education is important as it raises interest and awareness about the lake sturgeon's life history, historical and cultural significance to indigenous communities, and rehabilitation efforts. Education helps promote conservation of the species, improves identification among sturgeon species, and it may help discourage or assist in protection against illegal harvest.

Factor C–Disease or predation

3. Does the petitioner claim the entity warrants listing because of disease or predation?
   ☒ Yes
   ☐ No

a. If the answer to 3 is yes:
Identify which occurrence the petitioner claims is the reason that listing may be warranted (check all that apply)
☒ Disease
☒ Predation

b. If the answer to 3 is yes:
Do the sources cited in the petition provide substantial information to support the claim? Include consideration of existing regulatory mechanisms or conservation efforts identified in the petition or from other readily available information that may ameliorate the threats.
☐ Yes
☒ No

Disease

Citing Harkness and Dymond (1961), Choudhury and Dick (1993), Choudhury et al. (1996), and COSEWIC (2006), the petitioner states lake sturgeon are parasitized by trematodes, nematodes, acanthocephalans, cestodes, and coelenterates, which may weaken their hosts. Internal parasites are found in all life stages of a lake sturgeon as it is a natural part of its life cycle. A study conducted in the Winnebago system showed that presence and absence of parasite species in individual lake sturgeon is a strong indicator of diet and home range areas utilized for different life stages (Choudhury et al. 1996, pp. 280–281). There is a coelenterate, or jellyfish parasite (*Polypodium hydriforme*) that parasitizes only the eggs of sturgeons and paddlefish (Raikova et al. 1979, pp. 808–809; Choudhury and Dick 2001, p. 1418; Raikova 2002, pp. 411–412). The parasite feeds on egg yolk and escapes during spawning. The Cnidarian reproduces by fission. It is not known how sturgeon and paddlefish eggs are infected. We have no information that parasites threaten lake sturgeon populations.

Predation

The petitioner claims lake sturgeon populations are impacted by predation from invasive species, such as sea lamprey (*Petromyzon marinus*), silver lamprey (*Ichthyomyzon unicuspis*), round goby (*Neogobius melanostomus*), common carp (*Cyprius carpio*), and rusty crayfish (*Orconectes rusticus*). Invasive species are discussed below under Factor E.

Factor E–Other natural or manmade factors affecting the species' continued existence

4. Does the petitioner claim the entity warrants listing because of other natural or manmade factors affecting its continued existence?
☒ Yes
☐ No

   a. If the answer to 4 is yes:
   Identify the other natural or manmade factors that the petitioner claims is the reason that listing may be warranted.

- Invasive species
- Climate change
- Habitat fragmentation
- Lack of population viability
- Compromised genetic integrity
- Illegal harvest and poaching

b. If the answer to 4 is yes:
Do the sources cited in the petition provide substantial information to support the claim? Include consideration of existing regulatory mechanisms or conservation efforts identified in the petition or from other readily available information that may ameliorate the threats.
☒ Yes
☒ No

Invasive Species

Zebra and Quagga Mussels

Citing multiple sources (Jackson et al. 2002; McCabe et al. 2006; Criswell 2014), the petitioner claims that nonnative zebra mussels, which are found across most of the range of the lake sturgeon, may be a threat to sturgeon populations and recovery efforts including the Great Lakes. Zebra mussels may be a threat during several life stages of lake sturgeon but beneficial in other life stages. The petitioner claims zebra mussels may be detrimental to juvenile lake sturgeon habitat by preventing young sturgeon from recognizing or avoiding foraging grounds and reducing or impeding foraging success (Wesley and Duffy 1999, p. 64; McCabe et al. 2006, pp. 2, 5; Criswell 2014). Impacts to larger lake sturgeon are not likely a concern because larger lake sturgeon are known to consume zebra mussels. Zebra mussels may not affect the substrate where eggs are deposited. Some studies have shown that zebra mussels colonize the top layer of multilayered substrate of varying size rocky substrates and did not appear to affect the interstitial spacing that would affect dissolved oxygen levels required for proper development of eggs and larvae (Fitzsimons et al. 1995, p.13). High densities of zebra mussels can blanket river substrates and lakebeds changing the composition of silt sand substrates utilized by juvenile lake sturgeon. Lake sturgeon foraging on amphipod and isopods was reduced by the presence of 50% zebra mussel cover; overall, lake sturgeon foraging on amphipods was reduced by 90% (McCabe et al. 2006, p. 6).

Rusty Crayfish

Citing Caroffino et al. (2010), and MSU and MDNR (2015), the petitioner claims that the nonnative rusty crayfish (*Orconectes rusticus*) preys on lake sturgeon eggs and are potential predators of larval lake sturgeon, with negative impacts on lake sturgeon. Rusty crayfish are known to prey upon lake sturgeon eggs, but Caroffino et al. (2010) found that predation on larval and age-0 juvenile lake sturgeon was low and not limiting recruitment.

Roundy Goby

Citing multiple sources (Kempinger 1988; Nichols et al. 2003; Caroffino et al. 2010; MSU and MDNR 2015), the petitioner claims that round goby prey upon lake sturgeon eggs and larvae. The petitioner also claims that the presence of the botulism-E toxin has been reported in the stomachs of lake sturgeon, following the consumption of round gobies (citing Stone and Okoneiwski 2002) and that round gobies were the suspected cause of a 2001 botulism outbreak in eastern Lake Erie that killed at least 20 lake sturgeon (citing Criswell 2014). Consumption of infected prey may explain increased lake sturgeon mortalities in Lake Erie and Lake Ontario in the 2000s (Chalupnicki et al. 2011, p. 369). High densities of zebra and quagga mussels carrying the toxins in the Great Lakes were believed responsible for large die-offs of waterbirds, turtles, mudpuppies and piscivorous fish that ate large round gobies, which feed on zebra and quagga mussels. A 2004 binational workshop was held to address botulism in the Great Lakes. Study results shared in the workshop showed that gobies are susceptible to the botulism toxin and most died within 24-hour period from ingestion of the mussels. The infected gobies move slowly and erratically making them easy prey for walleye, smallmouth bass, and lake sturgeon. Wildlife and other species of fish have died from these botulism events.

Sea Lamprey

The petitioner asserts that juvenile and adult lake sturgeon in the Great Lakes are attacked and parasitized by sea lamprey and that the attacks, especially on younger lake sturgeon may result in mortality (citing GLFC 2007) and claims that warmer waters due to climate change may increase sea lamprey numbers, thereby increasing the lamprey's effect on native fisheries (citing NWF 2013, p.16; Huff and Thomas 2014). Huff and Thomas (2014, p. 70) indicates that sea lamprey numbers may increase with warmer water temperatures but does not provide any information on the impact to lake sturgeon or take into account ongoing efforts to control sea lamprey.

Other Invasive Fish

The petitioner claims that common carp (*Cyprius carpio*) feed on lake sturgeon eggs (citing Kempinger 1988; Nichols et al. 2003; Caroffino et al. 2010) and introduced non-native salmonids may prey on lake sturgeon larvae (citing Auer and Baker 2002; Auer 2003). We have no readily available information that would indicate that the level to which carp or salmonid predation may be happening is affecting lake sturgeon populations.

Invasive Plants

The petitioner also claims that invasive plants like purple loosestrife and Eurasian water milfoil have negative effects on native fish and macroinvertebrate populations (Wesley and Duffy 1999, p. 16). However, the petitioner did not provide information that would indicate a connection between purple loosestrife or Eurasian water milfoil to impacts to lake sturgeon. In addition to the above invasive species mentioned, increased spread of hydrilla and the aquatic plant's potential impacts to lake sturgeon and the fish community in the Ohio River basin is a growing threat to the population (USFWS 2018b). Hydrilla may overtake shallower areas of lower current making waters unsuitable for foraging juvenile and subadult sturgeon.

Climate Change

The petitioner claims that climate change will have a dramatic impact on lake sturgeon populations by increasing water temperatures and flows, decreasing dissolved oxygen, and increasing the toxicity of pollutants in freshwater systems (Ficke et al. 2007, p. 581), which would lead to decreases in the quantity and quality of habitat, disrupt timing and length of spawning, and interrupt the development and growth of embryos and juvenile rendering populations nonviable (Ficke et al. 2007, pp. 594, 595, 598). Optimal water temperature range for lake sturgeon spawning, egg development and survival may be impacted with rising temperatures predicted in the future in portions of the lake sturgeon's range. Optimal water temperatures for sturgeon spawning could shift, length of spawning season narrow, and egg and larval mortality increase. Since lake sturgeon do not spawn every year, future warming conditions may further shift their reproductive cycle, shorten seasonal length for optimal juvenile and adult growth, lower immune response to parasites and disease, and mortality may occur as a result of water temperatures beyond their tolerance levels if the lake sturgeon are not able to find areas of refugia.

Habitat Fragmentation

The petitioner claims habitat fragmentation from artificial barriers, such as dams and hydroelectric facilities, prevents movement to optimal habitats (Auer 1996, pp. 154, 157; Ferguson and Duckworth 1997, p. 303; Hay-Chmielewski and Whelan 1997, p. 31; Daugherty et al. 2009, p. 4) and altering stream flow (Baker and Borgeson 1999, pp. 1086–1087)) through isolation of populations, altering spawning behavior, preventing movement to optimal habitats, and reducing range size. This is discussed further under Factor A, Dams and Hydroelectric Facilities.

Vulnerable Life History Characteristics

The petitioner claims that the biological characteristics of lake sturgeon make populations particularly susceptible to decline (Beamesderfer and Farr 1997). Lake sturgeon are long-lived, slow to mature, spawn intermittently, and have high fecundity but low reproductive output. Lack of parental care of eggs or young (Kempinger 1988) may further contribute to low recruitment. Mortality of eggs and larvae is high with less than 1% estimated survival in the Age-0 juvenile stage (Nichols et al. 2003; Caroffino et al. 2010). After Age 1, there is low natural mortality in lake sturgeon. The life history traits of this ancient fish have withstood natural environmental changes through time, buts these traits make lake sturgeon vulnerable to overexploitation (MacKenzie 2016, p. 4). Lake sturgeon also rely upon specific habitats and conditions for successful spawning and recruitment of which the specific habitats have been blocked, fragmented or eliminated from many rivers. In addition to habitat decline affecting some lake sturgeon populations, certain populations exhibit poor reproductive success and low, or no, recruitment of wild juveniles to the adult population.

Lack of Population Viability

The petitioner claims that not a single U.S. population in the Lake Superior basin meets the criteria of a self-sustaining lake sturgeon population as defined by Auer (2003, p. 1) for that basin. Few Lake Superior lake sturgeon populations are considered fully rehabilitated; however, two populations—Bad River (WI) and Sturgeon River (MI)—currently meet self-sustaining criteria (Schloesser and Quinlan 2010; Hayes and Caroffino 2012) as described in the Lake Sturgeon Rehabilitation Plan for Lake Superior (Auer 2003). The petitioner did not provide any other information regarding viable populations.

Compromised Genetic Integrity

The petitioner asserts that stocking out of basin strains in restoration efforts, like the widely used Lake Winnebago strain presents genetic risks, such as outbreeding depression and reduced fitness (Welsh et al. 2010, pp. 4–8). The Winnebago lake sturgeon strain mentioned in the petition was used in early stocking efforts in Missouri on top of an existing Mississippi River population of low abundance resulting from the major decline in the population from overharvest. A genetic study completed by Drauch (2008, pp. 1204–1205) separated the Mississippi River strain from the Winnebago and Chippewa River strains. The Winnebago strain was used for several years before switching to Upper Mississippi River basin strain. Stockings date back to 1984 on the Mississippi and Missouri rivers. Consequences from this out-of-basin stocking will not be realized for years to come because of the long generation times of lake sturgeon and the presence of other lake sturgeon strains in the Mississippi River. This strain was also used in initial efforts in the Coosa River in Georgia. Survival of the stocked fingerlings in those initial efforts had poor survival, likely due to unsuitable water temperatures for this northern Wolf River strain. Out-of-basin sturgeon have been or are being used in several stocking programs (Bezold and Peterson 2008, p. 2).

Stocking of lake sturgeon should follow best management practices for genetic conservation as pointed out by the petitioner. Past decisions to use certain lake sturgeon strains to stock in specified waterways was based on the best available genetic information available at the time and agreement among recovery partners. In portions of the Great Lakes, local sturgeon broodstock are used in streamside rearing facilities, a common practice utilizing localized genetic strains. Out of basin strains may be appropriate where populations are extirpated.

Illegal Harvest and Poaching

The petitioner claims that the downward trajectory in sturgeon populations from the Caspian Sea caviar trade threatens lake sturgeon populations because global demand is far above what North American fisheries and the aquaculture industry can produce. Caviar demand and prices make it lucrative for sale on the black market. Potential collapse of Caspian Sea sturgeon places great risk to U.S. sturgeon and paddlefish populations. Illegal harvest is known to occur within the upper Mississippi River. As the upper Mississippi River stocked population continues to grow and reach sexual maturity, illegal harvest is expected to increase due to the high value of sturgeon roe or caviar on the black market (UMRCC 2004, p. 111).

Currently, concern is growing that as the stocked sturgeon population in the Missouri part of the Mississippi River reaches sexual maturity, there will be increased efforts to harvest sturgeon illegally and the illegal caviar mixed in with legally harvested shovelnose sturgeon caviar (MDC 2018). The increased numbers of Missouri River stocked lake sturgeon moving upriver into the border waters of Nebraska also raises concern by the Nebraska Parks and Game Commission that the lake sturgeon will become more vulnerable to harvest and would require further management and protection (Steffensen et al. 2014, p. 44).

In Vermont, the fish and wildlife department has responded to reports from anglers that they have seen illegally harvested lake sturgeon (MacKenzie 2016, p. 18). Illegal harvest of sturgeon could become a greater concern if sturgeon numbers increase in Lake Champlain and its tributaries (MacKenzie 2016, p. 18).

The petitioner provides accounts of poaching in reaches of the St. Clair, Black, Sturgeon, and Manistee rivers in Michigan. These are tributaries where lake sturgeon congregate to spawn, which places them at higher risk for illegal harvest because they are concentrated in shallow enough waters where they are visible and easy to illegally take.

The current level of illegal harvest is unclear in these areas. Watch groups like the Sturgeon Guard in Wisconsin and Michigan (Kline et al. 2009) along with law enforcement and fisheries personnel have had great success in protecting spawning sturgeon over the years. However, not all spawning sites will necessarily be protected as small populations start or continue to mature. These dedicated volunteer groups could serve as the framework for other sturgeon guards for populations of concern in the Midwest.

Factor D–Inadequacy of existing regulatory mechanisms

Factor D is considered in light of the other factors discussed above, not in a vacuum. The discussion of the claims under each factor above included a summary of information provided in the petition and contained other readily available information regarding how activities identified in the petition negatively affect the status of the entity and the extent to which existing regulatory mechanisms may ameliorate the threats such that the petitioned entity may or may not warrant listing or uplisting.

5. Does the petitioner claim that the entity warrants listing because of the inadequacy of existing regulatory mechanisms?

☒ Yes

☐ No

If the answer to question 5 is yes:
Identify the threats that the petitioner claims are not adequately addressed by existing regulatory mechanisms.

- Dam and hydroelectric facilities
- Contaminants
- Commercial fisheries
- Recreational fishing

Dams and Hydroelectric Facilities

The petitioner states that under the Fish and Wildlife Coordination Act (FWCA), the Federal Energy Regulatory Commission (FERC) is supposed to give fish and wildlife resources "equal consideration" with hydropower and other purposes of water resource development, and incorporate the recommendations of Federal and State fish and wildlife agencies. Further, the petitioner states that Section 10(j) of the Federal Power Act (FPA) allows the U.S. Fish and Wildlife Service to conduct environmental reviews and to make recommendations during relicensing that can benefit native fish such as lake sturgeon. The petitioner claims, however, that

FERC continues to license and re-license new or continuing hydropower and dam projects under the FPA with minimal or no provisions for lake sturgeon.

The petitioner also claims that the National Environmental Policy Act (NEPA) requires Federal agencies, such as FERC, to disclose potential environmental impacts of proposed actions but does not explicitly prohibit Federal agencies from choosing alternatives that may negatively affect individual sturgeon, sturgeon populations, or potential sturgeon habitat. In addition, the petitioner asserts that the Clean Water Act has little impact on the presence of dams and barriers.

The petitioner states that lake sturgeon could benefit in some areas from co-occurrence with other freshwater aquatic species, such as freshwater mussels, already protected under the federal Endangered Species Act. The petitioner asserts that Federal protection for freshwater mussels may help deter some new dam development on rivers, but it will not ensure that sufficient lake sturgeon habitat is protected and restored.

Information readily available in our files indicates that some gains have been made in reconnecting needed habitats for lake sturgeon by providing fish passage through dam removals. Measures to mitigate the impact of dams have been implemented to include construction of lifts to move lake sturgeon upstream, placing rock downstream of dams to serve as spawning substrate, and facilities that temporarily change "peaking" power to run of the river in spring during spawning season to avoid dewatering lake sturgeon eggs and leaving adult sturgeon stranded below dams. However, reviews for relicensing or new licensing do not always address the protection and movement of lake sturgeon and other fish species. In some cases, recommendations by State and Federal fish and wildlife agencies for habitat and biological studies, fish passage, and protective measures to reduce entrainment are not always incorporated into project plans.

Contaminants

The petitioner claims that the Clean Water Act does not restrict all potential contaminants, including non-point source pollution. The petitioner also claims the CWA program is underfunded for addressing widespread pollution problems. As evidence of the shortcomings of the Clean Water Act, the petitioner cites the listing of freshwater mussel species under the Endangered Species Act.

Commercial Fisheries

The petitioner states that the lake sturgeon was listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) from 1986 to 1996 as a "vulnerable" species but was delisted in 2004 and designated as a species of "least concern" (citing St. Pierre and Runstrom 2004). The petitioner claims that any party to the Convention may unilaterally state that it will not abide by the provisions relating to trade in a particular species listed in the Appendices, and CITES listing does not address habitat loss and degradation. However, the petitioner does not claim that lake sturgeon was erroneously removed from Appendix II of CITES.

Recreational Fishing

The petitioner claims that some States protect the lake sturgeon under State endangered species laws, and while most States do not allow recreational fishing for lake sturgeon, a few allow sport fishing for the species. The petitioner states that Kentucky, Michigan, Minnesota, and Wisconsin provide for a catch-and-release sport fishery, and Michigan and Wisconsin allow limited sport harvest of lake sturgeon. The petitioner also claims that many States allow for sport harvest of other sturgeon species, such as shovelnose, creating the potential for angler misidentification and inadvertent harvest of lake sturgeon. State protections for lake sturgeon are in place particularly where populations are vulnerable and are carefully monitored with adjustments made by state fish and wildlife agencies as necessary.

The petitioner states that lake sturgeon is protected and managed in Canada under the Federal Fisheries Act in each province of occurrence. The petitioner claims these regulations differ between provinces and are revised annually but have been subject to special regulation. The petitioner does not make any claims about the adequacy of these regulations.

The petitioner states that several tribes, primarily in Minnesota, Michigan and Wisconsin, manage lake sturgeon (citing Welsh 2004, p. 323). The petitioner asserts that restrictions on harvest in these tribal areas vary and can often differ from the regulations of the corresponding State, but coordination of management strategies and policies between states and tribes can be highly productive.

Cumulative Effects

When we have a substantial finding, we do not assess cumulative effects, and we address cumulative effects of threats in the 12-month finding. We only assess the cumulative effects of purported threats included in the petition if we find the petition does not present substantial information indicating the petitioned action may be warranted because of any one of the Factors (A, B, C, D, or E) individually.

6. If none of the answers to 1b, 2b, 3b, 4b, or 5 is "Yes," then we must consider whether there is substantial information indicating that the synergistic or cumulative effects of the threats may affect the entity such that it may warrant listing/uplisting. Do the sources cited in the petition provide substantial information indicating that the threats they have identified may have synergistic or cumulative effects such that the entity may warrant listing/uplisting?

☐Yes
☐No

Petition Finding

We reviewed the petition, sources cited in the petition, and other readily available information. We considered the factors under section 4(a)(1) and assessed the effect that the threats identified within the factors—as may be ameliorated or exacerbated by any existing regulatory mechanisms or conservation efforts—may have on the species now and in the foreseeable future. We considered a "threat" as any action or condition that may be known to or is reasonably likely to negatively affect individuals of a species. This includes those actions or conditions that may have a direct impact on individuals, as well as those that may affect individuals through alteration of their habitat or required resources. The mere identification of "threats" is not sufficient to compel a finding that listing may be warranted. We find that the petition presents substantial scientific or commercial information indicating that listing the lake sturgeon (*Acipenser fulvescens*) as a threatened species or endangered species may be warranted based on factors A, D, and E).

Under Factor A, information in the petition supports that populations of the lake sturgeon may be threatened by dams and hydroelectric facilities in the Red River, upper Mississippi River, Missouri River, Arkansas-White, Ohio River, and lower Mississippi River basins. The petition also provides support indicating that populations of the species and its habitat may be threatened by dredging and channelization activities and contaminants, such as PCBs, dioxins, and mercury. Under Factor E, information in the petition supports that habitat fragmentation, the species' life history characteristics, and invasive species may pose threats to the lake sturgeon and its habitat. Under Factor D, information in the petition provides support that existing regulatory mechanisms may not adequately protect the lake sturgeon from threats under Factor A.

Specific Requests for Information

Information on lake sturgeon populations for the purpose of determining whether any populations constitute a distinct population segment (DPS)

Author

The primary authors of this notice are the staff members of the La Crosse Fish and Wildlife Conservation Office and the Ecological Services program, Midwest Region, U.S. Fish and Wildlife Service.

FOR FURTHER INFORMATION CONTACT: Barbara Hosler, Midwest Regional Office, telephone 517–351–6326

Regional Outreach Contact: Georgia Parham, telephone 812–334–4261 ext. 203

Date: 11/8/18

ACTING

Charles Wooley
Acting Regional Director, Midwest Region
U.S. Fish and Wildlife Service

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