



FIND THE BULLSEYE: TARGETING CONSERVATION OF THE CANDY DARTER

Jemelyn Grace P. Baldisimo
Old Dominion University

Grade Level
7th Grade

Subject area
Life Science

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Title Find the Bullseye: Targeting Conservation of the Candy Darter

Focus Determining a species' risk of extinction using available data and spreading awareness for conservation of an endemic species.

Grade Level Life Sciences, Biology; target 7th grade, with ability to scale up to high school Biology

VA Science Standards

LS.1 The student will demonstrate an understanding of scientific and engineering practices by:
c) interpreting, analyzing, and evaluating data

- identify, interpret, and evaluate patterns in data
- construct, analyze, and interpret graphical displays of data
- compare and contrast data collected by different groups and discuss similarities and differences in their findings
- consider limitations of data analysis and/or seek to improve precision and accuracy of data
- use data to evaluate and refine design solutions

f) obtaining, evaluating, and communicating information

- read scientific texts, including those adapted for classroom use, to obtain scientific and/or technical information
- construct, use, and/or present an argument supported by empirical evidence and scientific reasoning

LS.9 The student will investigate and understand that relationships exist between ecosystem dynamics and human activity. Key ideas include

- a) changes in habitat can disturb populations

LS.11 The student will investigate and understand that populations of organisms can change over time. Key ideas include

- a) mutation, adaptation, natural selection, and extinction change populations;
- c) environmental factors and genetic variation, influence survivability and diversity of organisms.

BIO.7 The student will investigate and understand that populations change through time. Key ideas include

- b) genetic variation, reproductive strategies, and environmental pressures affect the survival of populations

Learning Objectives

- ✓ Students will collaborate to determine a fish species' extinction risk and conservation status by analyzing and interpreting available data provided.
- ✓ Students will discuss and defend their final assessment of a given species' conservation status.
- ✓ Students will apply their understanding of extinction risk by formulating a creative media project that can raise awareness and promote conservation of the candy darter

Total length of time required for the lesson

130 minutes total; Advance preparation of lab materials – 10 minutes, Lab setup – 5 minutes, Introduction – 30 minutes, Activity – 60 minutes, Presentations – 15 minutes, Wrap-up – 10 minutes.

Key words, vocabulary:

- **Endemic** - Found only in a certain area or country
- **Population** - A group of organisms occupying a specific geographic area
- **Geographic Range** - Extent of area where the species can be found
- **Habitat & Ecology** - Type of environment and conditions required by the species to survive, including any interactions it has with its environment and other organisms.
- **Uses & Trade** - Any benefit, good or service provided by the species
- **Threats** - Any activity or event that may cause harm or have a negative effect on a species population
- **Extinction Risk** – The possibility of a species becoming extinct in the near future, given current data on population trends, range, and threats to the population
- **International Union for Conservation of Nature (IUCN)** – One of the world's largest and oldest conservation organizations. IUCN is an institution composed of government departments and non-governmental organizations working together to address conservation issues.
- **Extinct (EX)** - The last individual for a species has died
- **Extinct in the Wild (EW)** - The species is known only to survive in cultivation, in captivity, or as a naturalized population (or populations) outside past its range
- **Threatened** – A species that is either Critically Endangered, Endangered or Vulnerable
- **Critically Endangered (CR)** - A species facing an extremely high risk of extinction in the wild
- **Endangered (EN)** - A species facing a very high risk of extinction in the wild
- **Vulnerable (VU)** - A species facing a high risk of extinction in the wild
- **Near Threatened (NT)** - A species that is not threatened now, but is close to qualifying for a threatened category in the near future
- **Least Concern (LC)** - A species that is not qualified as threatened or near threatened. Species that are LC are widespread and abundant.
- **Data Deficient (DD)** - A species that does not have enough information to make a direct or indirect assessment of extinction risk.
- **Not Evaluated (NE)** - A species that has not been evaluated using the IUCN criteria for extinction risk.

Background information

IUCN Red List of Threatened Species. The Red List of Threatened Species was created in 1964 by International Union for Conservation of Nature. It has information on the global risk of extinction for animal, plant, and fungus species. Like a barometer that measures air pressure, the Red List a

“barometer of life” that documents pressures faced by each species that may lead to extinction. Knowing about these pressures can allow us to prevent extinctions in the future. The Red Listing process considers factors that may affect a species population, including its biological characteristics, habitat, geographic range, uses, threats, existing research, and conservation laws or actions. The Red List can be used to find out whether a species falls in a certain category, such as Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, or Data Deficient. The Red List is a tool that can be used to raise awareness, guide future research, inform policy makers, or help conservation planners. This lesson simulates how experts do a Red List Assessment by looking at available data and collaborating to find out the Red List category of a fish species.

Candy Darter (*Etheostoma osburni*). The candy darter is a freshwater species that is only found in West Virginia and Virginia.

Student handouts

- Candy Darter Articles
- Species Summary Sheet
- Red List Criteria Questionnaires (Criteria A to E)

Materials & Supplies

- Computer and projector for presentation slides
- Student Handouts (as listed above)
- Teacher’s answer key for Species Summary Sheet & Red List Criteria Answer Keys
- Pen/Pencils
- Optional (Depending on instructor’s preference or what will be appropriate for creating final presentation posters): Coloring materials, colored papers, poster board/trifold

Classroom Set up

1. After doing the background/introduction presentation, the instructor can have students form 5 groups so that they can read the articles and answer questions for the criteria they are assigned to. Groups can have three to five members each. There is flexibility in the number of members, so instructors may choose however many would be a manageable number based on the number of students.
2. After the worksheets are done, students will create their creative media project that will raise awareness and promote conservation of the candy darter. This project can take the form of a poster, a video, or a song. Students should be encouraged to use their talents and formulate a creative project that will have a wider audience.

Procedure

Advance preparation of lab materials – 10 minutes

Prepare the lesson activity by printing handouts and worksheets in advance.

Each group should have a copy of:

- Candy Darter articles
- Species Summary Sheet
- Red List Criteria Questionnaires (Criteria A to E)

Students may also be sent soft copies of these files for reading and answering on a tablet.

Engagement

Begin the PowerPoint and talk about the concept of extinction, the IUCN Red List process, and how the Red List has been used for various animals. Refer to the presentation slides and talking points.

Exploration

- Highlight that in Virginia, there are a few fishes that have been assessed for their extinction risk. These species are listed in the presentation slides with some information on their habitat, distribution, threats, and any present conservation actions.
- There is one endemic freshwater fish, the candy darter (*Etheostoma osburnii*), that was last assessed for the IUCN Red List in 2011.

Explanation

- Explain to the class that they will now experience a simplified version of the Red List process. We will simulate what scientists and conservation managers do when they try to figure out the extinction risk for certain animals. Since this is a simulation, note that the information generated from the exercise should not be used as reference and the matrices are a mock representation of the actual IUCN Red List matrix that scientists consider when they assess extinction risk. The lesson plan is made with the objective of letting students become more aware of the IUCN Red List, but not an official training to become a Red List expert.
- Split the class into five groups. Five groups are recommended since there are 5 criteria used for the Red List process. Once groups are formed, distribute the *Red List Worksheet* and *Candy Darter Articles*.
- Walk through the information on the *Red List Worksheet* and explain that students must summarize information about the species first, then answer questions relating to the criterion they are assigned to. If they cannot find any information relevant to their criterion, then they should choose Data Deficient.

Elaboration

- Each group will report their assessment for the category assigned to them. The key for each criterion is as follows:
 - Criteria A: Vulnerable
 - Criteria B: Endangered
 - Criteria C: Data Deficient
 - Criteria D: Data Deficient
 - Criteria E: Data Deficient

- Once all groups finish reporting the conservation status based on their assigned category (3-5 mins each), the class should agree on a final conservation status. There are no right or wrong answers for the final conservation status but students should be encouraged to justify their answers. The following questions can help further explore their answers and stimulate a discussion:
 - Based on the references provided, will the Candy Darter be facing a very high risk (endangered) or a high risk (vulnerable) of extinction soon?
 - What do the Data Deficient criteria tell us? One perspective could be that more research is needed to answer these criteria. These studies could include counts of adults, probability of extinction and other relevant topics.
- The article from the US Fish & Wildlife Service says that the candy darter is 'Endangered' under the Endangered Species Act in 2018. If a student points this out, you may say that 1) IUCN is a different process, and 2) that the previous assessment was made in 2011, which is more than 10 years ago. Thus, if students think that based on what they read, it should be Endangered, then this could be a good justification.
- After the class agrees on the conservation status, allow students to go back to their own groups & proceed with Part 2 of the lesson where they are to form their creative media project. This project should allow them to raise awareness about the candy darter. Show examples of creative media projects for other species. Examples are in the presentation slides.
- Have each group present their creative media project to the class.

Differentiate for different skill sets and time available

- Modifications can be made based on classroom and time for activity:
 - Instead of having 5 groups, each group can work on all 5 criteria instead of only 1.
 - Presentations for the creative media project could be done in another class period to give time for students to prepare.
 - The instructor may also choose a uniform type of output. For example, all students can create posters only, letters to policy makers, or 1-minute commercials.

Evaluation

- Suggested closing questions:
 - What aspects of the fish species were important to consider when assessing their conservation status?
 - General idea: Several factors should be considered, including biological traits, use of the species, and other external threats. Answers may include, but are not limited to, population decline, geographic range, population size, uses, threats.
 - How did you decide on the conservation status? Were there any difficulties you encountered throughout this process?
 - How did you go about choosing your creative media project?

Assessment

Students will be assessed based on worksheet completion and final creative media project output.

Candy darter

Etheostoma osburni

Anglers Can Help!

Dump your unused bait in the trash, not the water. Do not transfer live fish bait from one stream system to another as this can upset natural fish communities and may lead to the decline of some species, including the candy darter.

Visit the waters of Virginia and West Virginia's upper Kanawha River Basin, and you might find yourself witnessing flashes of underwater rainbows. With their vibrant teal, red and orange colors, candy darters are a small freshwater fish native to the Gauley, Greenbrier and New River watersheds. Although darters in general make up 20 percent of freshwater fish species in North America, candy darters are found nowhere else.

Darters are an integral part of freshwater stream environments, and they also help other species in their life processes. For example, darters may aid in the reproduction of freshwater mussels – important filter feeders that keep rivers clean – by helping transport mussel glochidia (larvae).

Darters are also an important link in the aquatic food chain, feeding on smaller organisms before they themselves are eaten by larger fish.

Following a review of the best available scientific information, peer review, and public comment, the U.S. Fish and Wildlife Service listed the candy darter as endangered under the Endangered Species Act in November 2018. Nearly half of the 35 known candy darter populations have become obsolete since the species was first described in 1932.

Critical habitat has been designated for occupied streams within five watersheds in Virginia and West Virginia. This designation identifies areas that may need special management or protection by other federal agencies; they have no impact on landowner activities that do not involve federal funding or require federal permits.



T. Travis Brown

Named for their vibrant colors, male candy darters have five black saddles along their backs and nine to 11 vertical bands that alternate red-orange and blue-green along the sides of their bodies. Though females maintain a similar marking pattern, they appear mostly olive green and black.

Underwater Rainbows

The candy darter is small, measuring only 2-3 inches (55-86 millimeters) in length. This colorful fish prefers shallow, fast-flowing stream reaches with rocky bottoms.

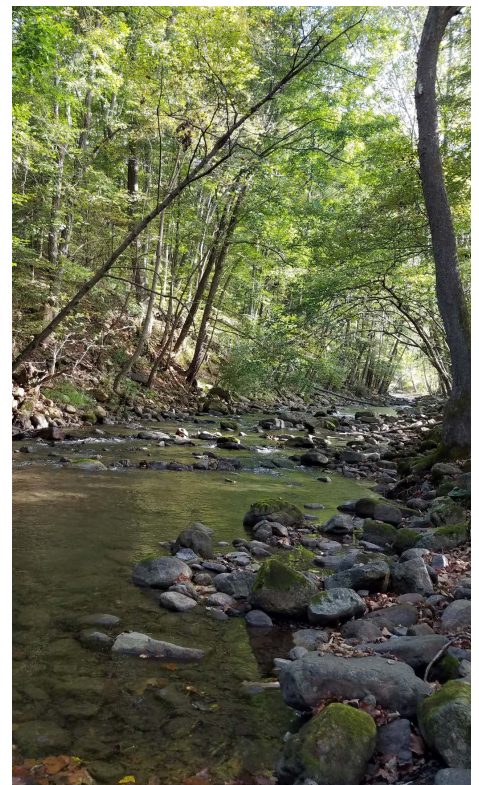
Candy darters live up to three years and begin breeding around two years of age. Spawning in mid- to late spring, candy darters are brood-hiding, bottom spawners. Females select areas of finer pebble and gravel among riffles to deposit their eggs.

Male candy darters display aggressive, territorial behavior during spawning. After nipping and chasing away competitors, the larger male successfully fertilizes the eggs. Incubation lasts five to 25 days depending on water temperature. Adult candy darters do not care for their young after spawning.

Candy darters primarily feed on small insects such as mayflies and caddisflies.

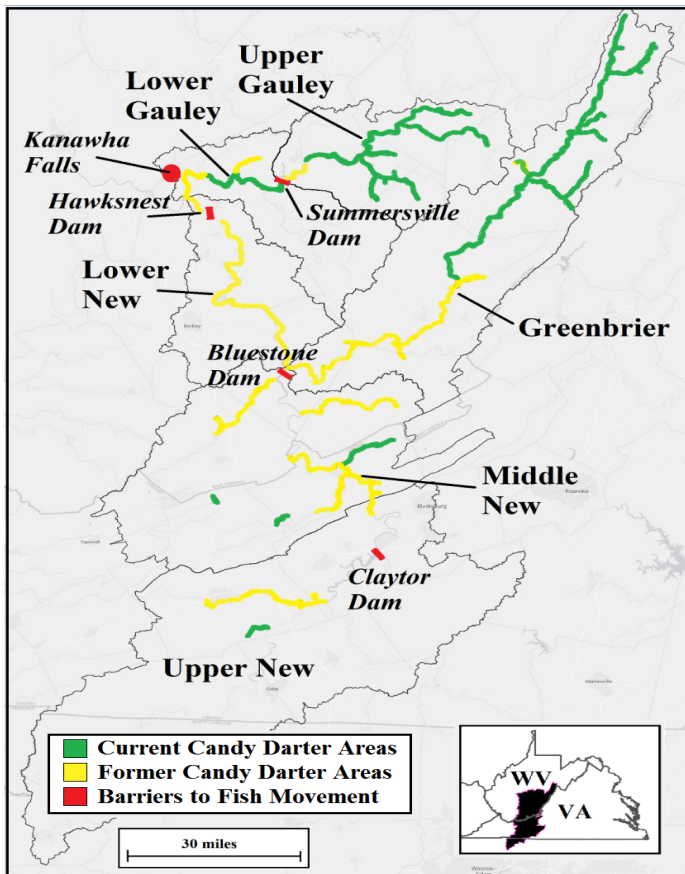
Vanishing Act

Candy darters were likely once relatively common throughout their range.



Krishna Gifford/USFWS

An example of stream habitat for the candy darter species in the Middle New River watershed in Virginia.



Dr. Stuart Welsh/USGS

As generations of hybridization progress, candy darter genes become increasingly diluted. Male candy darter (top); male hybrid specimen (middle); male variegate darter (bottom).

Hybridization and habitat loss have reduced candy darter presence in streams in which they were historically found. Green indicates existing populations and yellow indicates former candy darter areas in Virginia and West Virginia.

“May be the most vivid freshwater fish in North America.”
- A Field Guide to Freshwater Fishes, Page and Burr 1991

Historical habitat degradation and fragmentation led certain populations to dwindle or even cease to exist. Nearly half of the 35 candy darter populations known when the species was first described in 1932 have disappeared.

Now, an emerging threat is harming the remaining populations. The culprit? Introduction of another darter species.

Slightly larger in size, the variegate darter appears to outcompete candy darters for space, food and mates.

But most critically, the closely related variegate darter and candy darter can successfully mate with each other. This results in fertile hybrid offspring that are neither pure candy darter nor pure variegate darter.

After multiple, quickly successive generations of this mixing, candy darter genes are effectively diluted out of the population, and only variegate darters remain.

Variegate darters were once naturally blocked by the Kanawha Falls from

traveling upstream to candy darter populations. But in the late 20th century, variegate darters were released above the falls, likely as a result of their use as live bait for fishing.

Although variegate darter hybridization is ongoing, some populations of candy darters are protected by large dams that prevent the natural spread of variegate darters. Preventing the transfer of live baitfish into these watersheds is vital to the continued existence of candy darters in these areas.

Like many other darters, candy darters need very specific habitat features to survive and reproduce. Their presence generally indicates good water quality because they are affected by excessive sedimentation in rivers and streams. When sediment is released, it can fill the spaces between river bottom rocks, sometimes totally burying the gravel, pebbles, rocks and cobble that candy darters use for shelter and egg laying.

Other ways you can help candy darters:

- Safely and properly dispose of household and industrial chemicals so

they do not run directly into streams, and report chemical spills to state environmental protection agencies.

- During timber harvest, construction or other projects, implement best management practices for sediment and erosion control.
- Start a watershed group or assist in stream and water quality monitoring efforts.
- Plant trees and other native woody vegetation along stream banks to help restore and preserve water quality and prevent erosion.
- If you reside on property that borders a stream or other waterway, minimize use of chemicals or fertilizers.
- Maintain a buffer of natural vegetation along stream banks to help control erosion and reduce runoff.

U.S. Fish & Wildlife Service
1 800/344 WILD
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June 2019





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Press Release

Agency Finalizes Critical Habitat for Endangered Candy Darter

Designation helps partners conserve vivid freshwater fish in Virginia, West Virginia

April 6, 2021

Contact(s):

Meagan Racey, 413-253-8558, meagan_racey@fws.gov (mailto:meagan_racey@fws.gov)



Visit the waters of Virginia and West Virginia's upper Kanawha River Basin, and you might find yourself witnessing flashes of underwater rainbows: candy darters with their vibrant teal, red and orange colors. Though darters in general make up 20 percent of freshwater fish species in North America, candy darters are found nowhere else on earth. Credit: T. Travis Brown

Nearly half of candy darter populations documented since 1932 have disappeared. With the looming threat of losing one of North America's most vivid freshwater fish, the U.S. Fish and Wildlife Service protected the species as endangered in November 2018. The agency has now completed the next step required by the Endangered Species Act (ESA) - designating areas of habitat that are essential for its conservation.

The Service is designating 368 miles of occupied streams in Virginia and West Virginia as critical habitat for the species. Critical habitat focuses conservation efforts, but does not affect land ownership, set aside lands or establish a formal conservation area. The designation requires federal agencies to consult with the Service to ensure their actions do not destroy or adversely modify the habitat. The critical habitat designation only applies to the five watersheds where the darter persists and follows a review of the best available scientific information and economic analysis for the species.

Although streams designated as critical habitat are considered state waters, adjacent land is owned by a combination of federal, state and private interests. The designation does not affect landowner activities that do not involve federal funding or do not require federal permits. It does not allow the government or the public access to private lands, nor does it require non-federal landowners to restore habitat or recover species. However, the Service has programs available to assist landowners interested in habitat restoration, including the Partners for Fish and Wildlife Program in Virginia (<https://www.fws.gov/northeast/virginiafield/partners/partners.html>) and West Virginia (<https://www.fws.gov/northeast/virginiafield/partners/partners.html>).

Candy darter habitat historically declined when land conversion activities removed the forested and riparian habitat that sustained healthy stream conditions for the fish. Areas designated as critical habitat will be the focus for reducing sedimentation, protecting water temperatures, maintaining flows and reducing potential spills, among other activities.

These areas will also be the focus for minimizing the risk of introduction or spread of another darter species, the variegate darter. Biologists are concerned about the significant negative consequences of this darter breeding with candy darters. Variegate darters are not native to candy darter habitats but were likely inadvertently introduced into these areas as discarded bait fish.

Anglers can play a key role in candy darter conservation by disposing their unused bait fish in the trash rather than rivers or streams and by not using live fish bait in candy darter watersheds. Live bait fish can upset natural fish communities and may lead to the decline of some species, including the candy darter.

You can learn more about the candy darter and the final critical habitat designation here: <https://www.fws.gov/northeast/candydarter> (<https://www.fws.gov/northeast/candydarter/>) (<https://www.fws.gov/northeast/candydarter/>).

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Species Summary Sheet: Candy Darter (*Etheostoma osburni*)

GEOGRAPHIC RANGE:

Summarize information on where the Candy Darter is found, including which regions, states, or specific locations if possible.

POPULATION:

Summarize information population trends for the Candy Darter.

Historically, how many Candy Darter populations existed?

How many Candy Darter populations are left now?

What percentage of the population is left?

Formula: $(\text{Candy Darter populations now} \div \text{Candy Darter populations before}) \times 100$

HABITAT & ECOLOGY:

List down information on the Candy Darter's habitat and information on its biology (e.g. size, diet, reproductive method, ecological importance, spawning period, etc.)

USES:

Summarize information on the Candy Darter's uses (e.g. food, aquarium fish, etc.)

THREATS:

List down activities, events or situations that may negatively affect populations of candy darters.

EXISTING CONSERVATION ACTIONS:

List down any research being done or plans being implemented to conserve the Candy Darter

Species Summary Sheet: Candy Darter (*Etheostoma osburni*)

ANSWER KEY

GEOGRAPHIC RANGE:

Summarize information on where the Candy Darter is found, including which regions, states or specific locations if possible.

The candy darter is endemic or only found in the states of Virginia and West Virginia. It is found in the upper Kanawha River Basin, including the Gauley, Greenbrier and New River watersheds.

POPULATION:

Summarize information population trends for the Candy Darter.

It is estimated that 'nearly half of the 35 candy darter populations have disappeared since 1932'.

Historically, how many Candy Darter populations existed? 35

How many Candy Darter populations are left now?

Based on the write-up, acceptable answers are: About half, nearly half, ~17.5 populations are left

What percentage of the population is left?

Formula: (Candy Darter populations now ÷ Candy Darter populations before) × 100

~48.5 - 50%

HABITAT & ECOLOGY:

List down information on the Candy Darter's habitat and information on its biology (e.g. size, diet, reproductive method, ecological importance, spawning period, etc.)

Information under this section may include:

- Freshwater fish
- Size: 2 to 3 inches
- Matures in 2 years and lives up to 3 years
- Preferred habitat: Cool, fast flowing streams with depths
- Diet: Small insects found on the riverbed (e.g. mayflies & caddisflies)
- Ecological importance: Candy darters help freshwater mussels reproduce through helping transportation of mussel larvae in the water. They also serve as food for larger fishes.
- Spawning period: Mid to late spring
- Method of reproduction: "Brood-hiding bottom spawners" where females bury eggs in places with fine pebble and gravel while the male fertilizes eggs. Males become aggressive and territorial during reproduction period. Females produce fewer number of eggs compared to other fish species.

USES:

- There are no resources indicating that the Candy Darter is used for any purpose.

THREATS:

- *Habitat degradation* caused by sedimentation, increased water temperatures, and changes in water chemistry - Human activities and land use changes may contribute to habitat degradation in areas where the candy darter is present. Agriculture, forestry, mining, road or pipeline construction, and other human activities may cause land changes.
- *Habitat fragmentation* - Construction of barriers and impoundments to manage streamflow may lead to isolation of populations.
- *Hybridization with variegate darters (Etheostoma variatum)* - Late in the 20th century, variegate darters were widely used as live bait for fishing and were released above the Kanawha Falls. Both darters are similar in their habitat and ecology, but since the variegate darter is larger in size, has a bigger population, and can live in a wider range of habitats, it is able to outcompete candy darters in mating opportunities and resource use. If hybridization continues, eventually, candy darters may genetically disappear.

EXISTING CONSERVATION ACTIONS:

- Listed as Endangered in the November 2018 Endangered Species Act in. Areas where the Candy Darter is found are now 'critical habitats' that need special management and protection.
- Lessening use of chemicals or fertilizers and safely throwing away household and industrial chemicals to prevent polluting streams
- Preventing sedimentation and controlling erosion
- Help in water quality monitoring efforts
- Maintaining natural vegetation near stream banks or planting trees to prevent erosion and promote good water quality

Red List Criteria Questionnaire

CRITERIA A: Population Reduction

Use the matrix below to determine the Extinction Risk/Conservation Status of the Candy Darter

Did the population decline?	Are there potential threats in the future	Population decline was:	Extinction Risk/ Conservation Status
No	No		Least Concern
	Yes		Near Threatened
Yes		≥30-50%	Vulnerable
		≥50-70%	Endangered
		≥70-90%	Critically Endangered
No information available			Data Deficient

Note: For educational purposes only, not to be used for training or reference.

Red List Criteria Questionnaire

CRITERIA A: Population Reduction ANSWER KEY

Use the matrix below to determine the Extinction Risk/Conservation Status of the Candy Darter

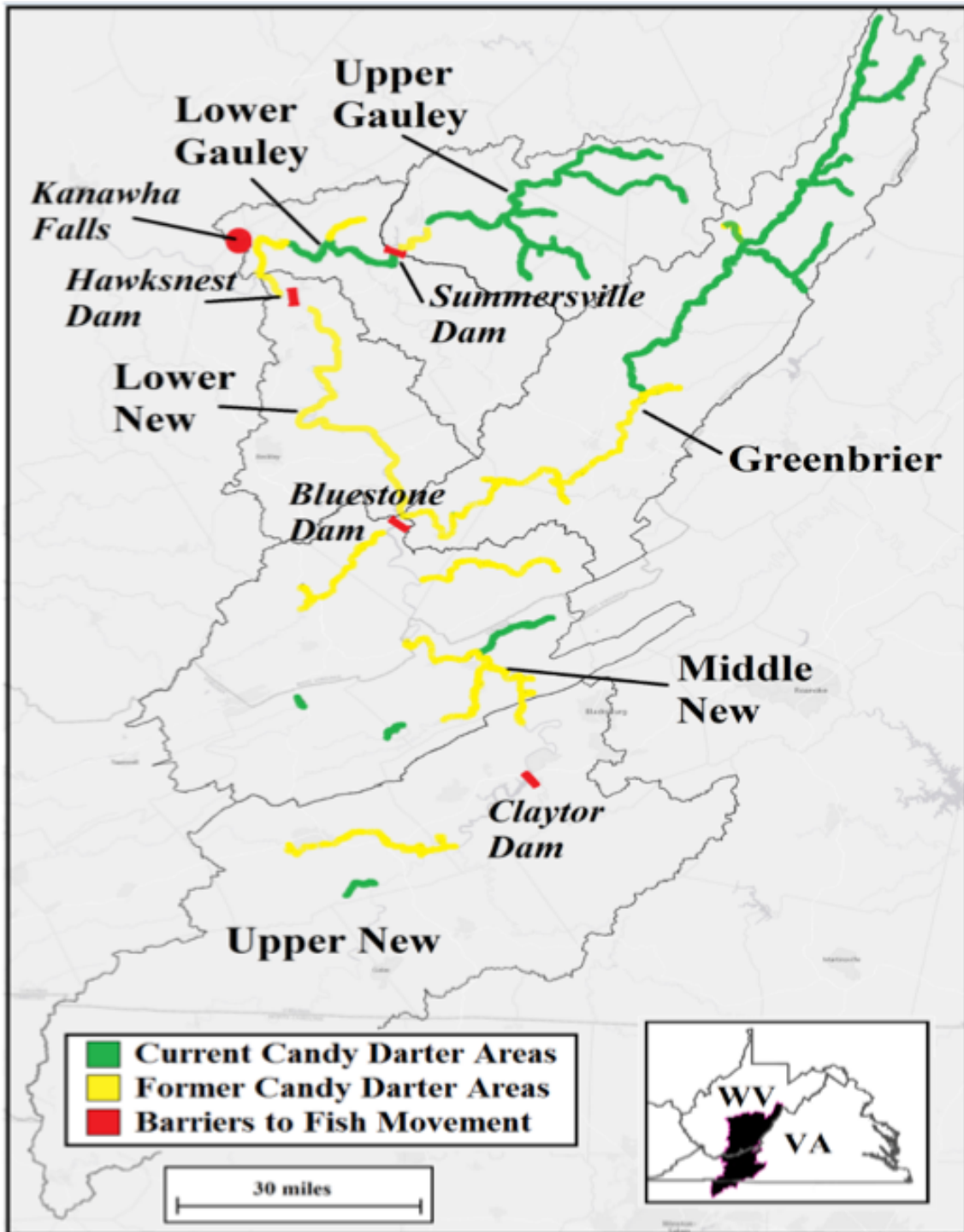
Did the population decline?	Are there potential threats in the future	Population decline was:	Extinction Risk/ Conservation Status
No	No		Least Concern
	Yes		Near Threatened
Yes		≥30-50%	Vulnerable
		≥50-70%	Endangered
		≥70-90%	Critically Endangered
No information available			Data Deficient

Note: For educational purposes only, not to be used for training or reference.

The best answer is Vulnerable due to the approximate range of decline, which is ≥30-50%.

Red List Criteria Questionnaire

CRITERIA B: Limited Geographic Range



Count the number of current & former Candy Darter areas (locations in **Bold**) _____

Count the number of current locations left (with Green or Green & Yellow) _____

Note: For educational purposes only, not to be used for training or reference.

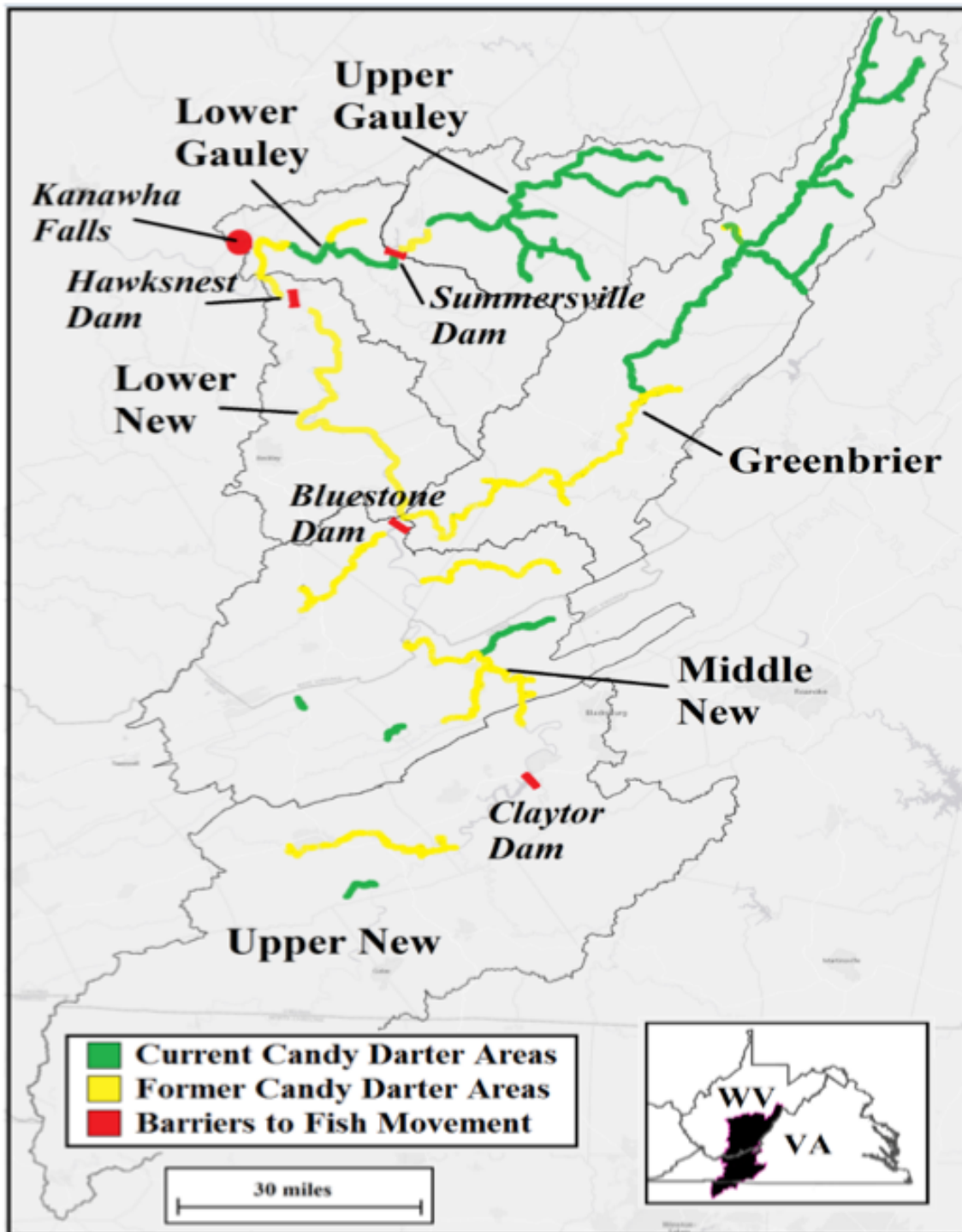
Use the matrix below to determine the Extinction Risk/Conservation Status of the Candy Darter

Does the Candy Darter have a limited geographic range?	Are there potential threats in the future	Number of locations left	Extinction Risk/ Conservation Status
No	No	>10	Least Concern
	Yes		Near Threatened
Yes		≤10	Vulnerable
		≤5	Endangered
		1	Critically Endangered
No information available			Data Deficient

Note: For educational purposes only, not to be used for training or reference.

Red List Criteria Questionnaire

CRITERIA B: Limited Geographic Range ANSWER KEY



Count the number of current & former Candy Darter areas (locations in **Bold**) 6

Count the number of current locations left (with Green or Green & Yellow) 5

Note: For educational purposes only, not to be used for training or reference.

Use the matrix below to determine the Extinction Risk/Conservation Status of the Candy Darter

Does the Candy Darter have a limited geographic range?	Are there potential threats in the future	Number of locations left	Extinction Risk/ Conservation Status
No	No	>10	Least Concern
	Yes		Near Threatened
Yes		≤10	Vulnerable
		≤5	Endangered
		1	Critically Endangered
No information available			Data Deficient

Note: For educational purposes only, not to be used for training or reference.

The best answer is Endangered due to the approximate number of locations left, which is 5 out of the 6.

Red List Criteria Questionnaire

CRITERIA C: Small population size and decline

Use the matrix below to determine the Extinction Risk/Conservation Status of the Candy Darter

Note: For this criterion to apply, you should have data for both adult population & decline in population within 3 to 10 years. Otherwise, it should be considered Data Deficient.

Does the Candy Darter have a small population of adults?	Number of adults	Are there potential threats in the future	Population decline was:	Extinction Risk/ Conservation Status
No		No	<10%	Least Concern
		Yes		Near Threatened
Yes	10,000		10% in 10 years	Vulnerable
	2,500		20% in 5 years	Endangered
	250		25% in 3 years	Critically Endangered
No information available				Data Deficient

Note: For educational purposes only, not to be used for training or reference.

Red List Criteria Questionnaire

CRITERIA C: Small population size and decline ANSWER KEY

Use the matrix below to determine the Extinction Risk/Conservation Status of the Candy Darter

Note: For this criterion to apply, you should have data for both adult population & decline in population. Otherwise, it should be considered Data Deficient.

Does the Candy Darter have a small population of adults?	Number of adults	Are there potential threats in the future	Population decline was:	Extinction Risk/ Conservation Status
No		No	<10%	Least Concern
		Yes		Near Threatened
Yes	10,000		10% in 10 years	Vulnerable
	2,500		20% in 5 years	Endangered
	250		25% in 3 years	Critically Endangered
No information available				Data Deficient

Note: For educational purposes only, not to be used for training or reference.

Since there is no information found in the articles on the number of adults, as well as declines within 3 to 5 years, the Candy Darter is Data Deficient for this criterion.

Red List Criteria Questionnaire

CRITERIA D: Very small or restricted population

Use the matrix below to determine the Extinction Risk/Conservation Status of the Candy Darter

Note: For this criterion to apply, you should have data on the adult population. Otherwise, it should be considered Data Deficient.

Does the Candy Darter have a small population of adults?	Number of adults	Number of locations left	Extinction Risk/ Conservation Status
No			Least Concern
			Near Threatened
Yes	<1,000	≤5	Vulnerable
	250		Endangered
	50		Critically Endangered
No information available			Data Deficient

Note: For educational purposes only, not to be used for training or reference.

Red List Criteria Questionnaire

CRITERIA D: Very small or restricted population ANSWER KEY

Use the matrix below to determine the Extinction Risk/Conservation Status of the Candy Darter

Note: For this criterion to apply, you should have data on the adult population. Otherwise, it should be considered Data Deficient.

Does the Candy Darter have a small population of adults?	Number of adults	Number of locations left	Extinction Risk/ Conservation Status
No			Least Concern
			Near Threatened
Yes	<1,000	≤5	Vulnerable
	250		Endangered
	50		Critically Endangered
No information available			Data Deficient

Note: For educational purposes only, not to be used for training or reference.

Since there is no information found in the articles on the number of adults, the Candy Darter is Data Deficient for this criterion.

Red List Criteria Questionnaire

CRITERIA E: Quantitative Analysis

Use the matrix below to determine the Extinction Risk/Conservation Status of the Candy Darter

Note: For this criterion to apply, you should have data on the probability of extinction of the candy darter. If there is no quantitative study, then it should be considered Data Deficient for this criterion.

Probability of Extinction	Are there potential threats in the future?	Extinction Risk/ Conservation Status
≤10% in 100 years	None	Least Concern
	Yes	Near Threatened
≥50% in 10 years	≤5	Vulnerable
≥20% in 20 years		Endangered
≥10% in 100 years		Critically Endangered
No information available		Data Deficient

Note: For educational purposes only, not to be used for training or reference.

Red List Criteria Questionnaire

CRITERIA E: Quantitative Analysis ANSWER KEY

Use the matrix below to determine the Extinction Risk/Conservation Status of the Candy Darter

Note: For this criterion to apply, you should have data on the probability of extinction of the candy darter. If there is no quantitative study, then it should be considered Data Deficient for this criterion.

Probability of Extinction	Are there potential threats in the future?	Extinction Risk/ Conservation Status
≤10% in 100 years	None	Least Concern
	Yes	Near Threatened
≥50% in 10 years	≤5	Vulnerable
≥20% in 20 years		Endangered
≥10% in 100 years		Critically Endangered
No information available		Data Deficient

Note: For educational purposes only, not to be used for training or reference.

Since there is no information found in the articles on quantitative studies, the Candy Darter is Data Deficient for this criterion.

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Find the Bullseye: Targeting Conservation of the Candy Darter

Determining an endemic species' risk of extinction using available data and spreading awareness for conservation.

Prepared by: Jem Baldisimo



OLD DOMINION
UNIVERSITY

Jem Baldisimo

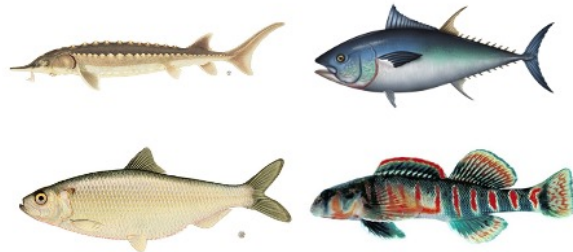
- From the **Philippines** – country with the most types of marine fishes in the world!
- PhD candidate at ODU
- I study: Which aquarium fishes are more likely to be **extinct** in the future?



My name is Jem Baldisimo. I grew up in the Philippines, the country with the most diverse marine fishes. I am a PhD candidate at ODU studying which aquarium fishes are more likely to disappear in the future.

Lesson Overview

- Extinction & Extinction Risk
- IUCN Red List
- Threatened Fishes in the Chesapeake Bay
- Extinction Risk of the Candy Darter



In this lesson, students will learn about extinction and extinction risk, the IUCN Red List, some threatened fishes in the Chesapeake Bay based on the IUCN Red List. We will try to see how the IUCN Red List process can be used to find out the extinction risk of the Candy Darter.

EXTINCTION

when the last individual of a species has died



Why should we care about extinction?

1. Nature supports human well-being
2. Balanced Biodiversity = healthy ecosystems
3. All species have the right to exist

Let's go right in and talk about extinction, which occurs when the last individual of a species has died. You may have heard about the dinosaurs that became extinct a long time ago. Extinction has been happening at a faster rate and is directly caused by human activity.

Why should we care about extinction?

- First, nature provides humans with many things food, shelter, and other things that help us survive. We must take care of our environment as it takes care of us.
- Second, a balanced biodiversity leads to health ecosystem. Everything is interconnected and if one species disappears, then the web of life will be disrupted.
- Third, whether a species is valued by humans or not, they have a right to exist. If human activity is enough to cause a species to disappear, then that should be taken as a sign that the activity is too damaging

Passenger Pigeons: Once widespread, now extinct



How the once widespread American Passenger Pigeon became extinct is one of the most dramatic stories of extinction.

Native to North America, it was once the most common bird in the world.

At one time, there were 5 billion passenger pigeons. There were enormous flocks of these birds. One flock would be 1 mi wide by 300 mi long and have about 2 billion birds.

Unfortunately, they were hunted to extinction. Many poor people in the US between the 17 to 1800s ate no other meat except the passenger pigeon.

In 1914, the last passenger pigeon died in the Cincinnati Zoo. She was named Marth after Martha Washington.



THE IUCN RED LIST
OF THREATENED SPECIES™

Estimating Extinction Risk



One way to estimate the likelihood of extinction or extinction risk for a species is through the IUCN Red List of Threatened Species. Let's watch a video about the IUCN Red List.



THE IUCN RED LIST
OF THREATENED SPECIES™

Estimating Extinction Risk

- Uses available data
- Objective process
- Quantitative approach

Uses of the Red List:

- Raise awareness
- Conservation planning & policy making
- Environmental impact assessments
- Monitor species populations

The Red List uses available data on a species, follows an objective process and uses a quantitative approach to finding out the extinction risk of a species.

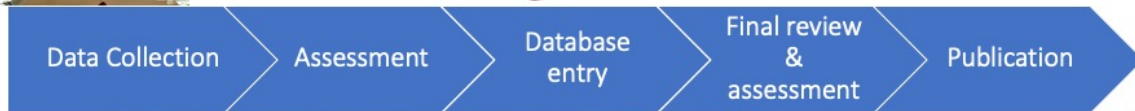
The Red list can raise awareness of the general public for the need to protect a species and the environment. It can be a reference for conservation planning, policy making, environmental impact assessments, and help monitor species populations through time.



THE IUCN RED LIST OF THREATENED SPECIES™

Estimating Extinction Risk

Red Listing process involves:

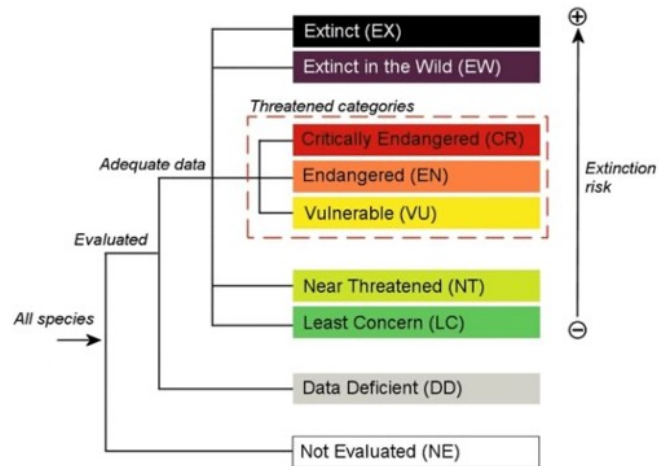


Completing and publishing a Red List assessment takes a bit of time. The process involves collecting information from scientific literature, interviewing experts, holding workshops to conduct the assessment, entering information in a database, final review, and then publishing in the IUCN website.



THE IUCN RED LIST
OF THREATENED SPECIES™

9 Categories



There are 9 Red List categories that a species can be listed under. I will briefly describe the meaning of each one, but I want to draw your attention specifically to what we refer to as the 'threatened' categories in the red box here, which are Critically Endangered, Endangered and Vulnerable



THE IUCN RED LIST
OF THREATENED SPECIES™

9 Categories



The last individual for a species has died



The species is known only to survive in cultivation, in captivity, or as a naturalized population (or populations) outside past its range



THE IUCN RED LIST
OF THREATENED SPECIES™

9 Categories



A species facing an extremely high risk of extinction in the wild



A species facing a very high risk of extinction in the wild



A species facing a high risk of extinction in the wild

These three categories are the threatened categories.



THE IUCN RED LIST
OF THREATENED SPECIES™

9 Categories



A species that does not qualify as threatened now, but is close to qualifying for a threatened category in the near future



A species that is not qualified as threatened or near threatened. Species that are LC are widespread and abundant.



THE IUCN RED LIST
OF THREATENED SPECIES™

9 Categories



A species that does not have enough information to make a direct or indirect assessment of extinction risk.

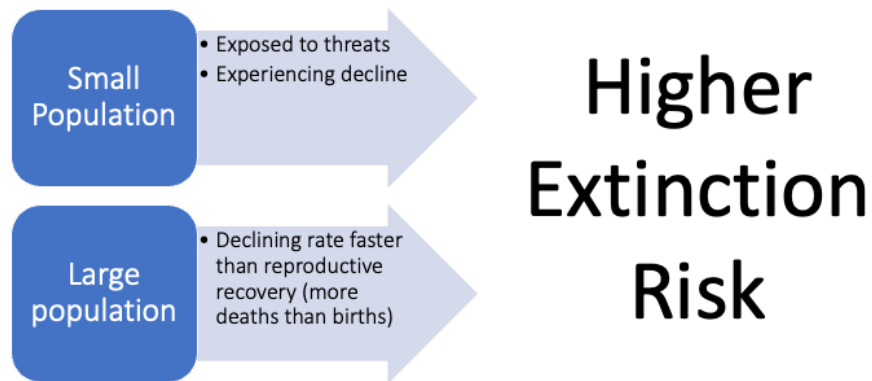


A species that has not been evaluated using the IUCN criteria for extinction risk.

If there isn't enough information to figure out a species' extinction risk, it can be tagged as Data Deficient. Species that have not been evaluated against the Red List Criteria are called NE or Not Evaluated.

Extinction Risk Theory

Two paradigms (Mace *et al.* 2006):



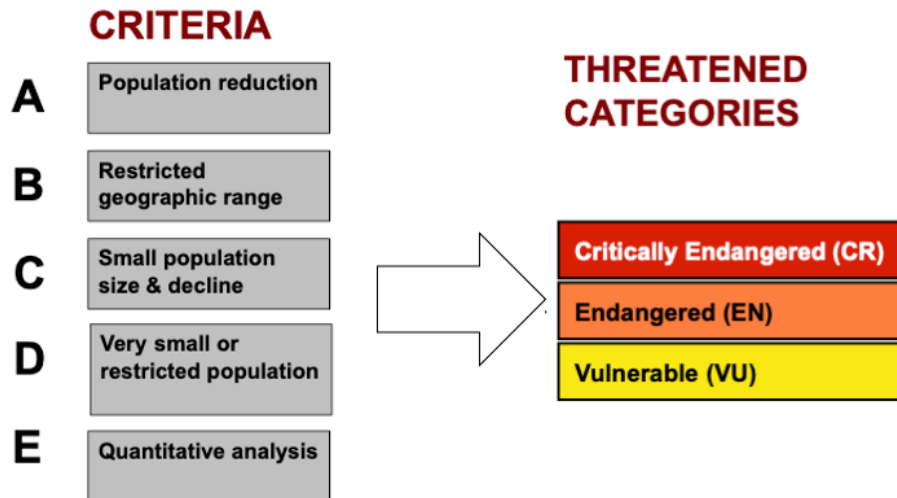
Before we talk about the criteria that is used, it is worth discussing the Extinction Risk Theory, which gives a prediction on which populations are more likely to become extinct. This theory is based on two paradigms: the small population paradigm and the declining population paradigm.

This theory says that if you have a small population that is exposed to threats and is experiencing a decline, then this population will have a higher risk of becoming extinct.

On the other hand, when you have a widespread or large population, but its population is declining faster than its capacity to recover, then it will have a higher extinction risk. If you think about it, this is what happened to the Passenger Pigeons!

The IUCN Extinction Risk criteria uses this concept when finding out Extinction Risk for a species.

Red List Criteria



- There are five Red List Criteria (A-E), each of which are independent of each other and based on a different issue related to extinction risk.
- Each criterion has a set of quantitative thresholds that determine which (if any) of the threatened categories a species qualifies for. Red List experts undergo a training to become Red List assessors. Later today, you will learn a simplified version of this so that you can get a glimpse of how the assessments are done.

Red Listed fishes in the Chesapeake Bay



Atlantic Bluefin Tuna (*Thunnus thynnus*)

- **Range:** North Atlantic Ocean (Canada to Brazil, Mediterranean, West Africa)
- **Habitat:** Oceanic, lives in open sea
- **Uses & Trade:** Highly valued game fish, Japanese sashimi market
- **Threats:** Overfishing, habitat loss, oil spills
- **Conservation measures:** Fishery managed at international level, strict US fishing regulations since 2010

Let's take a look at some fish species found in the Chesapeake Bay that have been tagged as Threatened in the IUCN Red List. The first one is the Atlantic Bluefin Tuna.

It is a highly valued game fish and caught for sashimi.

Its fishery is managed internationally and locally. Currently, it is Least Concern, although years ago, it was Endangered.

Red Listed fishes in the Chesapeake Bay



Atlantic Sturgeon (*Acipenser oxyrinchus*)

- Largest native Chesapeake fish
- Range: Canada to Florida
- Habitat: Lives in ocean, spawns in rivers & estuaries
- Uses & Trade: Food (flesh & caviar)
- Threats: Harvesting (7 million tons taken in 1887), habitat degradation due to dams & other development, pollution
- Conservation measures: Fishing ban, dam removal, listed in 2012 US Endangered Species Act

The next one is the Atlantic Sturgeon, the largest Native Chesapeake fish. It used to be caught for its flesh & eggs (for caviar). It is currently Near Threatened and to prevent further declines, some conservation measures like fishing bans and dam removals have been done. It is listed under the US Endangered Species Act.

Red Listed fishes in the Chesapeake Bay



Blueback Herring (*Alosa aestivalis*)

- Eaten by larger fish like Striped Bass
- Range: Canada to Florida
- Habitat: Schools in ocean, spawns in rivers & estuaries
- Uses & Trade: Food, fish meal, fish oil
- Threats: Harvesting, habitat degradation due to dams
- Conservation measures: Fishing ban in VA since 2012

The blueback herring is Vulnerable in the IUCN Red List. It was caught for food and used as fish meal and for making fish oil. Since 2012, fishing blueback herring in Virginia was banned.

Activity:

Find the Bullseye: Targeting Conservation of the Candy Darter



The candy darter is another interesting fish found only in West Virginia & Virginia. Here's a video of this colorful freshwater fish. The last IUCN Red List Assessment for this species was made in 2011. You have a task to help update the IUCN Red List Assessment for this fish since the last assessment was made 10 years ago.

Activity



Your task:

- PART 1: Agree on the extinction risk of the Candy Darter (*Etheostoma osburni*)
- PART 2: Create a media project to spread awareness & conservation of the Candy Darter

Now that you've learned about the IUCN Red List, we you are going to try and assess its conservation status or extinction risk of the Candy darter and after that, create a media project to spread awareness & conserve the candy darter.

Activity

PART 1: Agree on the extinction risk of the Candy Darter

1. Read article & fill in Candy Darter Fact Sheet:

- Geographic Range
- Population
- Habitat & Ecology
- Uses
- Threats
- Existing conservation measures

To find out the extinction risk of the Candy Darter, you will read an article and fill in the Candy Darter Fact Sheet for the following: Geographic range, population, habitat & ecology, uses, threats and existing conservation measures

Activity

PART 1: Agree on the extinction risk of Candy Darter

2. Each group be assigned one criteria to evaluate extinction risk:

- Group 1 - Population Reduction
- Group 2 – Restricted Geographic Range
- Group 3 – Small population size & decline
- Group 4 – Very small or restricted population
- Group 5 – Quantitative Analysis

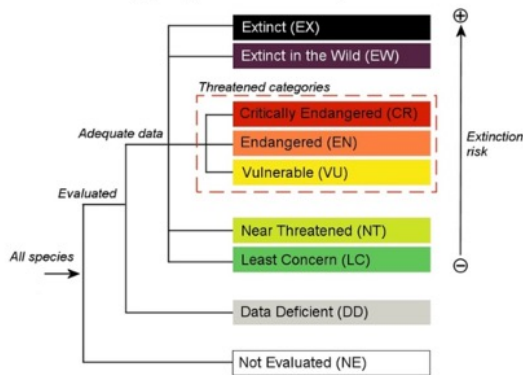
Note: If there is no data available for your criterion, it should be considered Data Deficient.

After filling in the sheet, each group must evaluate extinction risk based on the Red List Criteria that will be assigned to them. Note that if in the article, you cannot find anything that relates to your criterion, then you can say that it is Data Deficient for your criterion.

Activity

PART 1: Agree on the extinction risk of the Candy Darter

2. After each group reports their findings, the class will agree on the which category the candy darter belongs to:



Criteria A: ?
Criteria B: ?
Criteria C: ?
Criteria D: ?
Criteria E: ?
Final Category: ???

Note: proceed with Part 1 activity after this slide

The Candy Darter



Now that you've agreed on the Extinction Risk/Conservation Status of the Candy Darter, let's proceed to Part 2 of the activity. Let's watch this news segment on the Candy Darter.

Activity

PART 2: Create a media project to spread awareness & promote conservation of the Candy Darter

- Poster/artwork
- Song
- Video



Endangered Species by Andy Warhol

Knowing the conservation status of the Candy Darter, you must create a media project that can spread awareness and promote its conservation. Here are some examples of posters, artwork, songs, and videos that raise awareness on endangered animals or threatened species.

Activity

PART 2: Create a media project to spread awareness & promote conservation of the Candy Darter

- Poster/artwork
- Song
- Video



Photo credit: Lynn Englum @vanishing places

This is an outdoor installation featuring the Candy Darter.

Activity

PART 2: Create a media project to spread awareness & conservation of the Candy Darter

- Poster/artwork
- Song
- Video



This is an example of an infographic about the Candy Darter

Activity

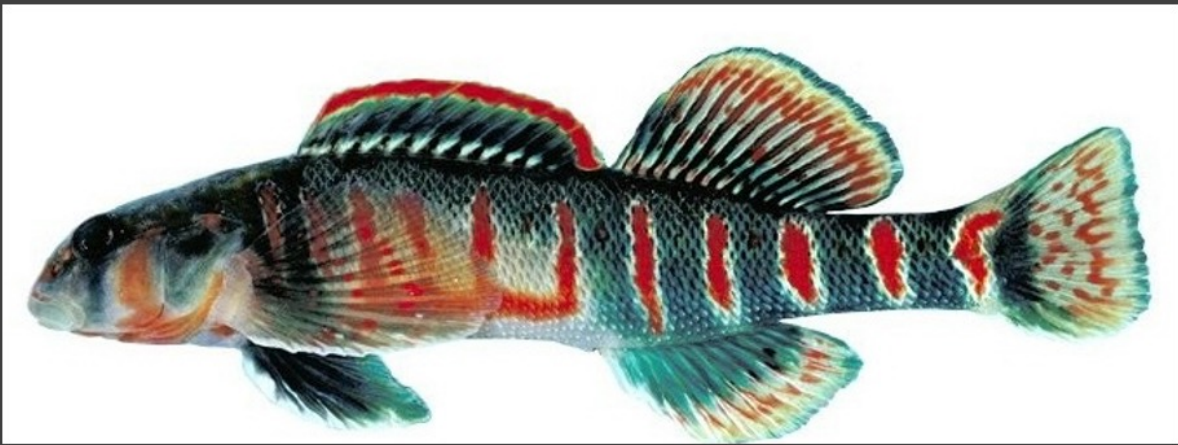


Here's an example of a 1-minute video for raising awareness on wolves & encouraging its re-listing as endangered

Activity



Here's a song promoting the protection of endangered animals



Reflection
Questions:

- What are important things to consider when finding out a species' extinction risk?
- What difficulties did you encounter as you discussed the final Red List Category?
- How did you go about choosing your creative media project?



What can you do for species conservation?

- Spread awareness about the Candy Darter
- Read about how to lessen your impact on the environment
- Check out the IUCN Red List Website (<http://iucnredlist.org>)
- Find ways to contribute to scientific research

If the students have other ideas than what has been mentioned here, ask them to share them too!