<u>Lionfish Presentation Notes for Teachers</u>

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Lionfish Invasion

- Introduce who the Florida Fish and Wildlife Conservation Commission is:
    - Manage natural resources throughout the state of Florida. This is a state agency, part of the state government.
    - The Division of Marine Fisheries Management oversees:
        - Rule-making for saltwater fishing in Florida (licenses, permits, fishing rules). Based on scientific research of fisheries.
        - Outreach programs about marine life
        - Artificial Reef deployments and maintenance
        - Lionfish control, studies, and outreach programs

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What is an Invasive Species?

- Start with asking if students know what an invasive species is and whether they have heard of some examples like the ones below.
- Clarify the definition of an invasive species. Make sure students know the difference between a nonnative and an invasive species:
- **Nonnative** species have not caused negative consequences and/or have not become established so they do not have a significant impact on the ecosystem.
- **Invasive Definition**: Invasive species can negatively impact human health, the economy (i.e. tourism, agriculture), and native ecosystems. These impacts may disrupt the ecosystem processes, introduce diseases to humans or flora and fauna, and reduce biodiversity.
- Research has demonstrated that invasive species have characteristics that allow them to outcompete native species and change biodiversity, community structure, and ecosystem processes in a region
- Invasive species negatively impact native populations via direct predation on smaller species, habitat degradation, introduction of pathogens and competition for resources

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Invasive vs. Nonnative

- Species that have been introduced by people into a region outside their natural habitat can be described as Nonnative or Invasive. Make sure students understand the difference between these labels.

- **Nonnative** species have not caused negative consequences and/or have not become established so they do not have a significant impact on the ecosystem.
- **Invasive** species can negatively impact human health, the economy (i.e. tourism, agriculture), and native ecosystems. These impacts may disrupt the ecosystem processes, introduce diseases to humans or flora and fauna, and reduce biodiversity.
- **Established** refers to a species that has become a part of the ecosystem and is reproducing successfully. Unless there is interference from an outside force (humans, disease, habitat destruction) then the organism will be a permanent part of the ecosystem.

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Invasion Trend

- Invasive species tend to follow a predictable pattern
- This pattern is not exact but does represent a reasonable expectation of how invasive species will expand within a new habitat
- There is generally a lag time or delay after the first introduction of an invasive species (this is the first slight incline under the word introduction)
- This is followed by rapid and exponential growth as the invasive species expands into new habitat and uses available resources (steep curve up to tallest point)
- Eventually there is a slowing of growth followed by a slight decline (and potentially cannibalism, depending on species) as the invasive species runs out of new habitat and resources
- The invasive population then reaches a plateau where a stable population size is maintained. This is the carrying capacity (maximum size) of the population that the ecosystem can support

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Marine Invasions

- 41 other nonnative marine fishes in Florida are known and this number is likely to grow as climate change affects species distribution
- While 5 other nonnative species have become established, they do not create the negative impacts seen from lionfish and some have had no noticeable effect
- One notable species is the fish on the far right, the Regal Demoiselle, an Indo-Pacific species now being reported in the Gulf of Mexico. Its effects are not yet known
- Some species have also been brought through aquarium releases but several have expanded north from the Caribbean to the waters around Florida (i.e. Fairy Basslet 2nd from right)
- Lionfish are the most damaging and best established of all marine fish invasions to date
- Most reports of non-native marine fishes have come from citizen scientists, emphasizing the importance of education about native reef species

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Lionfish

- The two names in italics are the scientific names of lionfish. There are over 20 species of lionfish in the world but only two that have invaded Florida waters:
    - The Red Lionfish (*Pterois volitans*) and the Fire Devilfish (*Pterois miles*)
- **Established** – introduced and now reproducing and successfully living in new habitat
- Recent study found that introduction via aquarium release of over 118 individuals from Indo-Pacific – not believed to be a result of ballast water from ships (Selwyn et al 2017)
- This indicates that lionfish in the Atlantic, Caribbean Sea and Gulf of Mexico are very similar genetically
- Lionfish in the invaded range reach up to 19" while only reaching 15" in their native habitat
- Groups of lionfish in the invaded range are fare more dense than in their native habitat where they are sporadically distributed.

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Sightings Map

- First observed in southeast Florida off Dania Beach in 1985
- In almost 30 years, the population has spread up the Atlantic coast of the US, down throughout the Caribbean Sea, and around the Gulf of Mexico
- Most rapidly-expanding marine invasion in history

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- Lionfish have now been spotted off the coast of Brazil
- Note the sightings in New England: lionfish cannot survive water temperatures below 50° F but can stay temporarily in the New England area during the summer when temperatures are higher.

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Invasive Characteristics

- Essentially no marine habitat that lionfish have not been able to invade
- Lionfish have successfully invaded the waters of both the Atlantic and Gulf coasts of Florida and can inhabit a wide range of salinity, depths, and water quality.
- Dense populations of lionfish can be found in deeper waters offshore on natural and artificial reefs, hard-bottom structures and ledges, as well as in shallow, inshore environments within bays, estuaries, and rivers.

- The number of eggs is not a remarkable trait of lionfish. Many reef fishes spawn tens of thousands of eggs at a time. It is unusual that lionfish use a strategy of spawning for months rather than a narrow window of a week or several days like other reef fishes. This increases their chances of eggs reaching maturity.
- Inhabit all marine habitats throughout their invaded region from shore to 1,000 ft
    - Coral reefs, seagrass beds, artificial reefs, mangroves and even estuarine environments
- Found as far north as Rhode Island, but cannot sustain winter water temperatures; minimum water temperature controls latitudinal distribution – can tolerate temperatures as low as 50 degrees Fahrenheit
- Wide salinity tolerance – from estuarine and riverine (<4ppt) to full-strength seawater (35ppt)
- Demersal species, meaning they live on the ocean floor, often under ledges, overhangs, and in crevices; primarily active during the dawn and dusk
- Have a high site fidelity – they do not tend to migrate far distances – post larval stage; stay within a small radius, although can recruit to nearby patch reefs

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Anatomical Terms

- Important terms to know:
    - **Dorsal** – the back of the fish (where the spine is)
    - **Ventral** – belly of the fish; underside
        - **Pectoral fin** – side fins of fish
        - **Pelvic spines/fin** (2) – front underside of fish. One spine at the front (**anterior**) edge of each fin
        - **Anal spines/fin** – back underside of fish. 3 spines at front edge of this fin
        - **Caudal fin** – tail fin of fish
        - **Dorsal fin** – back of fish towards the tail. This is the section of fin behind the spines
        - **Dorsal spines** – 13 spines on the back of the fish starting above the head

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Venomous vs. Poisonous

- It is important for students to understand the difference in biology definitions between the two

- Poisons are chemicals (a toxin) that an animal produces which is absorbed by another organism in some way such as touching, eating or breathing it in.
- Venomous organisms produce venom (a chemical) that must be injected into another organism for either defensive or predatory purposes generally through a sharp structure like a fang or spine.
- Lionfish have venomous spines purely for defense and do not use them as a weapon or predatory tool

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Lionfish Diet

- Lionfish prey on juvenile specimens of economically important species such as grouper, snapper, crustaceans (crab, lobster, shrimp)
- Without large numbers of juveniles of these species, the adult populations cannot be replaced as they age or are removed through fishing
- By preying mainly on economically important species, lionfish can significantly affect fisheries health. Fewer juveniles means fewer adults of these species can be removed by diseases, age, or fishing before the population will collapse

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Lionfish Diet (2)

- Lionfish also prey on ecologically important species such as grazers/herbivores (parrotfish, damselfish, wrasses)
- Parrotfishes and wrasses remove algae which allows sunlight to reach coral polyps which photosynthesize for food. Without sunlight, corals will die and the habitat will shift towards a mostly algae covering
- Cleaner shrimp help remove parasites and reduce the spread of diseases or parasites in fish populations. Without these cleaner species, the effects of diseases will be more significant

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Effects on Native Ecosystems

- Opportunistic generalists – lionfish will prey on any convenient species up to ½ their own body size. They rotate between prey items based on what is most easily captured/available
- Known to prey on more than 90 species of fish and invertebrates
- Native predatory species exhibit avoidance and are not actively preying on live lionfish
- **Recruitment** – when juveniles of a species join a population of older individuals through immigration or birth

- Reduction in recruitment and prey biomass:
    - 79% reduction in juvenile fish recruitment to new reefs observed in the Bahamas (Albins & Hixon 2008)
    - 2.6 times reduction in recruitment compared to a native predator (Albins 2013)
    - 65% reduction in prey biomass (Green et al. 2012)

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Effects on Native Ecosystems (2)

- No known control mechanism for lionfish in the invaded range – no parasites, no diseases, no predators that consistently target lionfish
- Non-consumptive Effects:
    - Even larger predators such as adult groupers and snappers will avoid competing with lionfish for habitat and prey (Raymond et al., 2014)
    - Lionfish prey on algae-eaters, which causes a shift to an algae-dominated habitat and damages coral reef structures (Lesser & Slattery 2011)
    - Humans are the only known consistent predator that can remove lionfish from the ecosystem. It is estimated that removing 65% of adult lionfish on a reef will allow native predators to re-establish in the ecosystem (Morris et al, 2010)

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Lionfish Landings by Gear Type

- Lionfish landings by type of fishing gear used includes trawl, traps, hook and line, and diving
    - Most lionfish are captured by spearfishing while diving
    - **Trawls** – large nets dragged on the bottom of the ocean behind a boat
    - **Traps** – modified lobster, crab or fish traps (usually a wooden or metal box with an opening on one side)
    - **Hook and line** – traditional rod and reel fishing
    - **Diving** – SCUBA divers with pole spears or hand nets to capture lionfish at depth

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Programs about Lionfish

- FWC has numerous programs to help remove lionfish and educate the public about them
- Diver programs sponsored by FWC:
    - Not required to hold a recreational license to catch lionfish and regulations make it easy to target lionfish so the public can get involved

    - FWC provides financial assistance for lionfish tournaments where SCUBA divers catch lionfish for prizes
    - Sponsored contests every summer (Lionfish Challenge) for divers to win prizes for catching lionfish. There is also a program to provide financial assistance to dive boats that take people hunting for lionfish
    - FWC supports several research projects that test traps and ROVs (remotely operated vehicles) to catch lionfish in new ways
- Education programs:
    - FWC staff provide online materials, presentations, and in-person dissection presentations with students and interested groups
    - Staff travel to events and tournaments around Florida to provide information about lionfish to the public
    - Every May, the Lionfish Removal and Awareness Day event is a weekend with a festival and tournament for lionfish that starts our summer programs
- FWC encourages divers to sell their lionfish catch (with a commercial license) and for restaurants and markets to sell lionfish to encourage people to catch and eat them

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Video

- This video was taken offshore south of Carrabelle, FL by several FWC divers in 2015
- This is a small wreck about 100 feet underwater and divers find several hundred lionfish covering the wreck
- Note that few other species of fish are on this wreck after lionfish have moved in