Conceptual Model of Predation and Survival (CMPAS)

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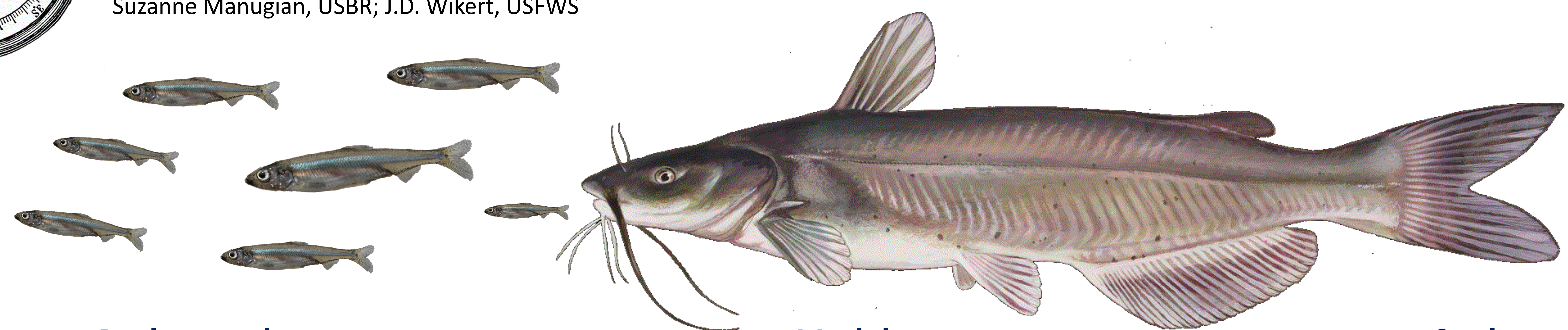


Background

Native fishes of the Sacramento-San Joaquin Delta and connected freshwater ecosystems face many stressors, including predation. Predation is multifarious and interactions among specific drivers are not always well understood. A subgroup of the IEP Predation Project Work Team has developed a conceptual model to help guide predation-related research and management.

Model

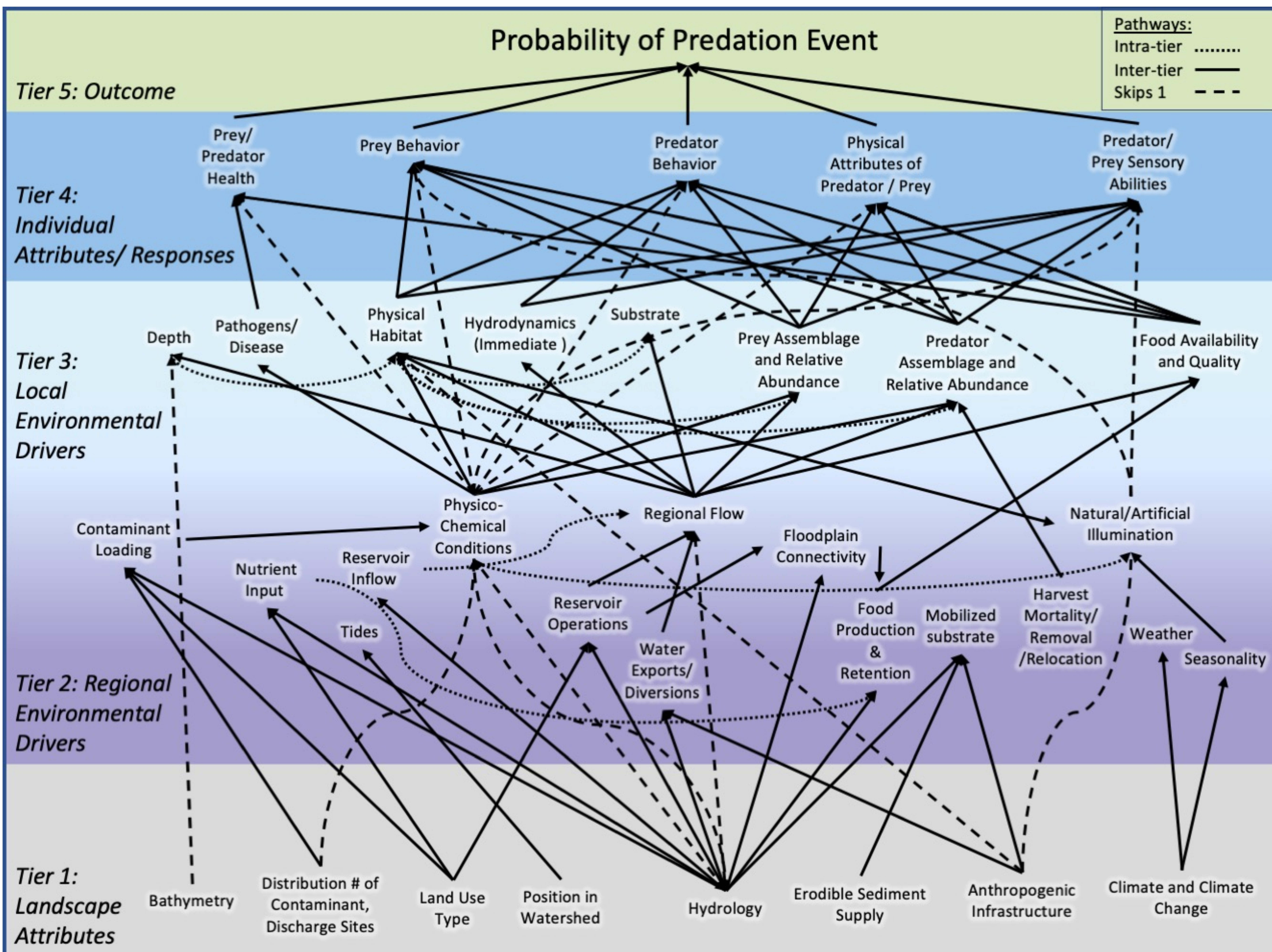
The base model is neither species- nor spatially-specific and serves as a template for more detailed models focused on species and habitats of interest. It is intended to encompass most potential predator types (fishes, birds, and mammals).

The model follows a 5-tiered approach scaling from landscape level attributes to predation risk (see below).

Goal

The goal of this ongoing effort is a conceptual model that allows construction of multiple hypotheses that can guide research and evaluate management actions within an adaptive framework.

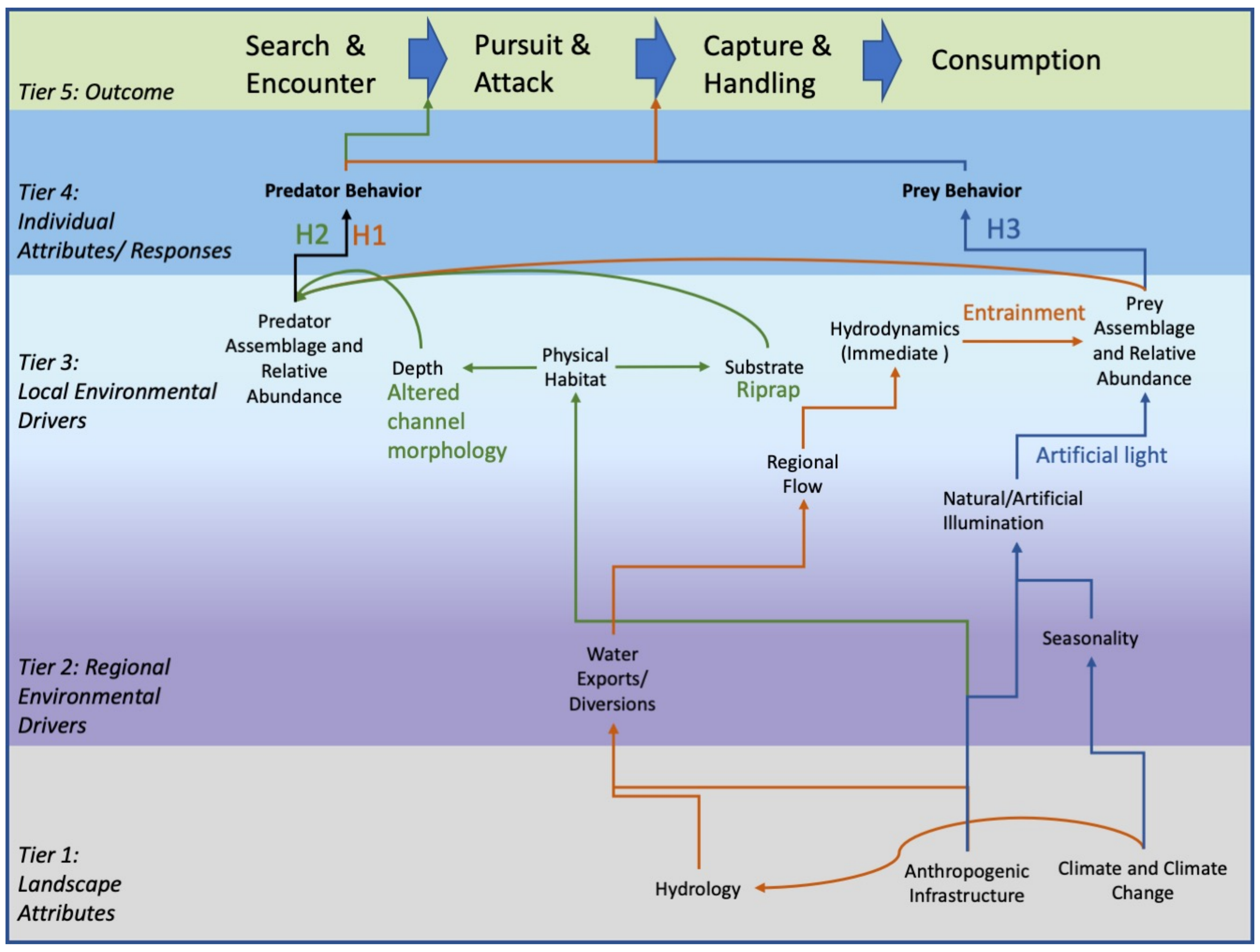
We welcome input so please feel free to contribute your expertise by leaving a comment on the discussion forum or emailing us.



CMPAS Sub-models: Examples of hypothesized pathways

(A more complete list of hypotheses and associated literature can be found in the supplemental materials)

Behavior



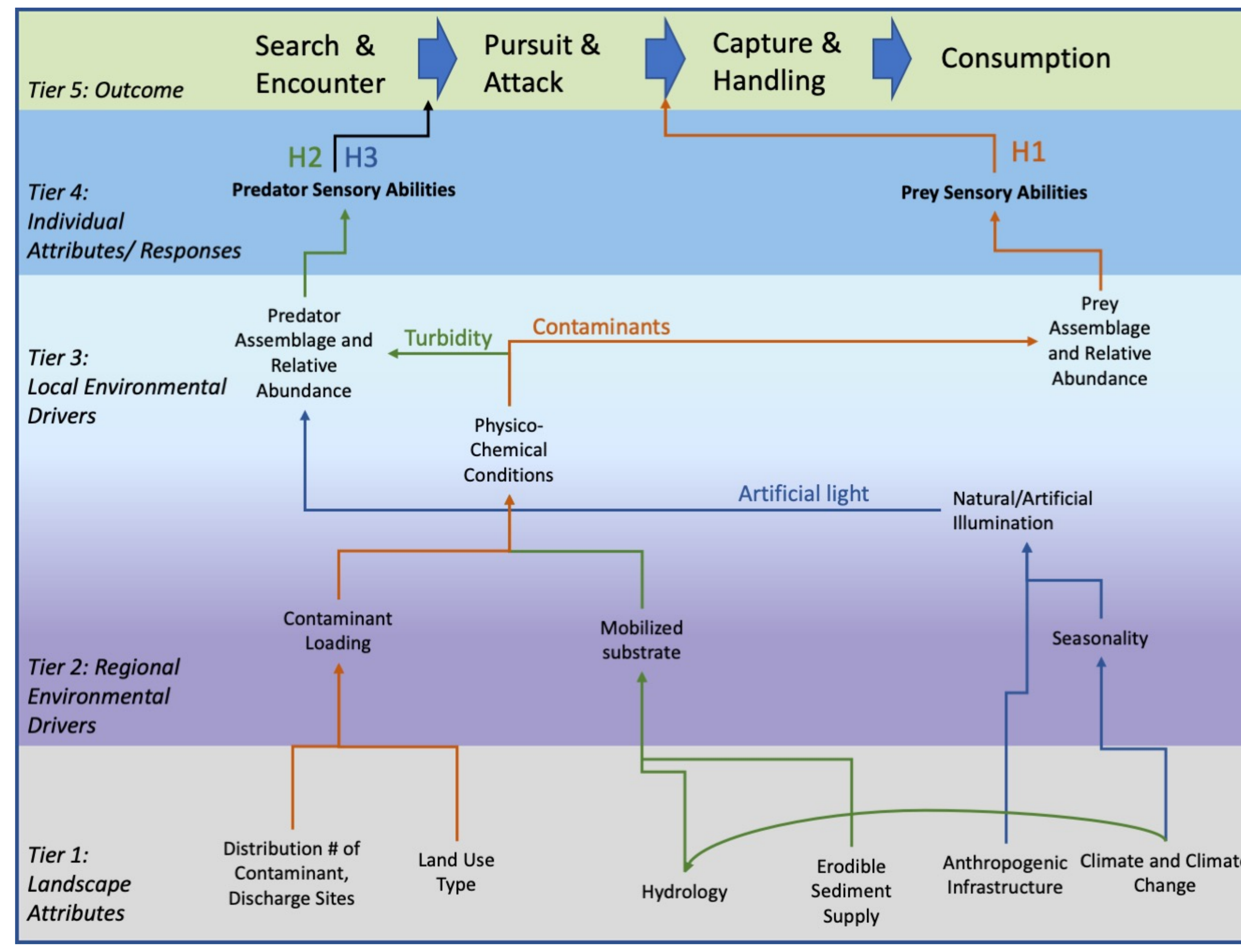
Specific variables thought to influence the predation process by affecting *predator and/or prey behavior* might include immediate hydrodynamics, artificial lighting, and habitat preferences.

H1: Water diversions attract/entrain prey fishes which leads to a numerical and/or functional response from predators (18).

H2: Riprap or artificial substrates attract predators increasing localized predator density making a predation hotspot (9, 23).

H3: Artificial lighting attracts prey species making them more vulnerable to predators (1, 8, 21).

Sensory



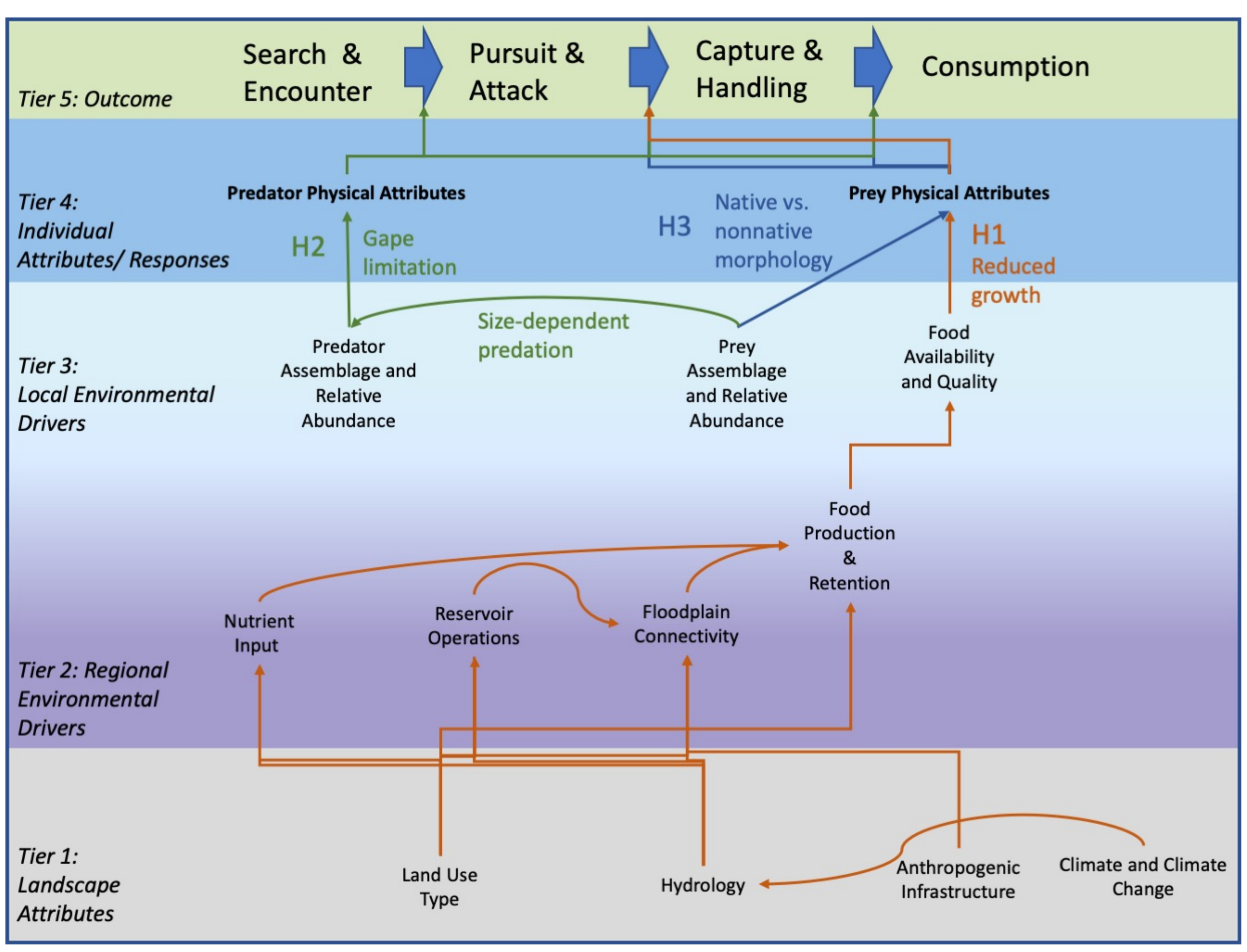
Specific variables thought to influence the predation process by affecting *predator and/or prey sensory abilities* might include turbidity, artificial lighting, or contaminants.

H1: Contaminants inhibit the olfactory ability of prey fishes to sense predators and disturbance cues (2, 5, 19, 22).

H2: Increasing turbidity decreases visual detection of prey fishes by predators (4, 6, 25, 26).

H3: Artificial lighting increases the ability of predators to see prey fishes during crepuscular and nocturnal time periods (3, 21).

Physical Attributes



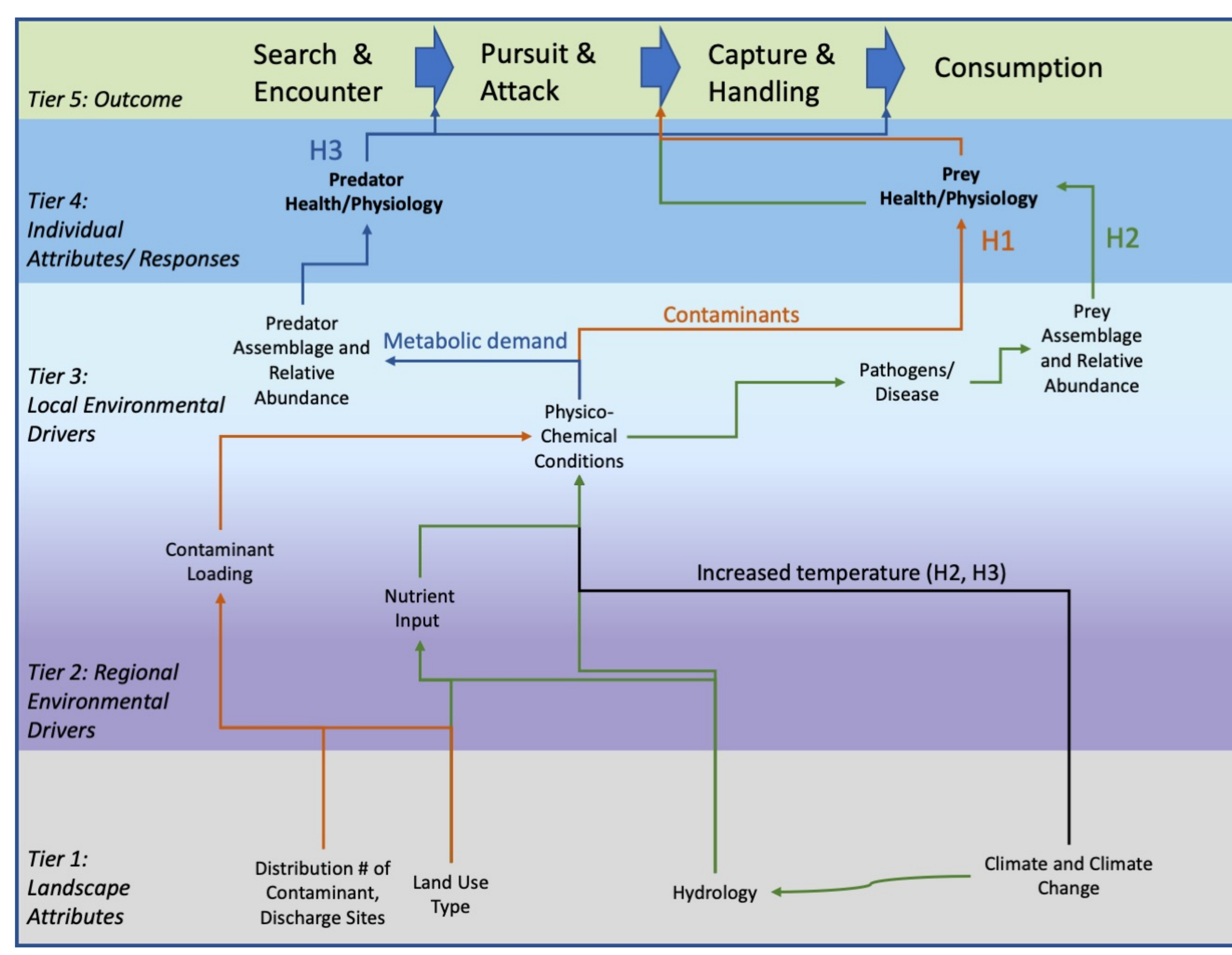
Physical attributes of predators thought to influence the predation process include body size, gape size or jaw protrusion (fish), swimming speed, flight and bill shape (avian), and claws/talons (mammalian/avian). *Physical attributes of prey* include body size, body depth, spines or plates, and swimming ability.

H1: Low food availability resulting from decreased floodplain connectivity decreases prey fishes growth rates and size, preventing prey from outgrowing predation risk from certain sizes classes of gape-limited predators (10, 24).

H2: Predators exhibit size-dependent prey selection to maximize net energy gain, thus consumption rates of small prey species may be influenced by density of small–intermediate sized predator species and/or interaction between size-classes of predator species. (7, 12, 16).

H3: Morphology (e.g., deep-bodied, spiny fin rays) of certain fishes (especially nonnatives) disproportionately prevents them from being preyed on by native species that did not evolve to consume prey with that morphology forcing native predators to increase reliance on native prey fishes (8).

Health/Physiology



Variables thought to influence predation through *health/physiology aspects of predator and/or prey* might include contaminants, presence of parasites or pathogens, nutrition through food availability, and temperature.

H1: Increased contaminant load within prey species decreases evasion response leading to an increase in successful predation attempts (14).

H2: Increased prey parasite load or pathogen prevalence decreases evasion response abilities leading to an increase in successful predation attempts (11, 15).

H3: Increases in temperature increase the bioenergetic demand of predators leading to increased predation rates (17).

Acknowledgements: The authors would like to thank the Interagency Ecological Program (IEP) for support and program guidance. Thanks to all the members of the IEP Predation Project Work Team and associated sub-teams for their participation in the development and review of materials. The views expressed are those of the authors and do not represent the official opinion of any employer, institution or government agency.

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Supplemental Material: Conceptual Model of Predation and Survival (CMPAS) Expanded list of hypotheses and additional literature

(* Indicates hypothesis included on the poster, blue colored text indicates additional hypotheses)

Behavior

Specific variables thought to influence the predation process by affecting predator and/or prey behavior might include immediate hydrodynamics, artificial lighting, and habitat preferences.
***H1:** Water diversions attract/entrain prey fishes which leads to a numerical and/or functional response from predators (18).
***H2:** Riprap or artificial substrates attract predators increasing localized predator density making a predation hotspot (9, 23).
***H3:** Artificial lighting attracts prey species making them more vulnerable to predators (1, 8, 21).
H4: Spatial overlap of native prey fishes and non-native fishes with early ontogenetic diet shifts to piscivory may diminish recruitment of native fishes by increasing predation in shallow nursery/rearing areas (27,29,31,34)
H5: The continuous release of salvaged fishes at established fish release sites leads to a numerical and/or functional response from predators and a subsequent decrease in survival of these salvaged fishes (28,32,35).
H6: Agonistic/competitive interactions with non-native fishes can displace native fishes from preferred feeding/habitat areas leading to higher vulnerability to predation (33).

Sensory

Specific variables thought to influence the predation process by affecting sensory abilities might include turbidity, artificial lighting, or contaminants.
***H1:** Contaminants inhibit the olfactory ability of prey fishes to sense predators and disturbance cues (2, 5, 19, 22).
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***H1:** Low food availability resulting from decreased floodplain connectivity decreases prey fishes growth rates and size, preventing prey from outgrowing predation risk from certain sizes classes of gape-limited predators (10, 24).
***H2:** Predators exhibit size-dependent prey selection to maximize net energy gain, thus consumption rates of small prey species may be influenced by density of small–intermediate sized predator species and/or interaction between size-classes of predator species. (7, 12, 16).
***H3:** Morphology (e.g., deep-bodied, spiny fin rays) of certain fishes (especially nonnatives) disproportionately prevents them from being preyed on by native species that did not evolve to consume prey with that morphology forcing native predators to increase reliance on native prey fishes (8).
H4: The body morphology, fin structure/placement, jaw and buccal structure, etc. of certain non-native fishes (e.g., Striped Bass, Largemouth Bass) allows for novel or refined predation tactics that native fishes have not co-evolved with and therefore leads to a higher vulnerability to predation (36).

Health/Physiology

Variables thought to influence predation through health/physiology aspects might include contaminants, presence of parasites or pathogens, nutrition through food availability , and temperature.
***H1:** Increased contaminant load within prey species decreases evasion response leading to an increase in successful predation attempts (14).
***H2:** Increased prey parasite load or pathogen prevalence decreases evasion response abilities leading to an increase in successful predation attempts (11, 15).
***H3:** Increases in temperature increase the bioenergetic demand of predators leading to increased predation rates (17).
H4: Poor nutrition in prey through decreased food availability and/or quality decreases evasion response abilities leading to an increase in successful predation attempts (24).
H5: Increases in temperature decrease growth rates and may produce thermal stress responses in certain native prey fishes that increase predation vulnerability leading to an increase in successful predation attempts (30).

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