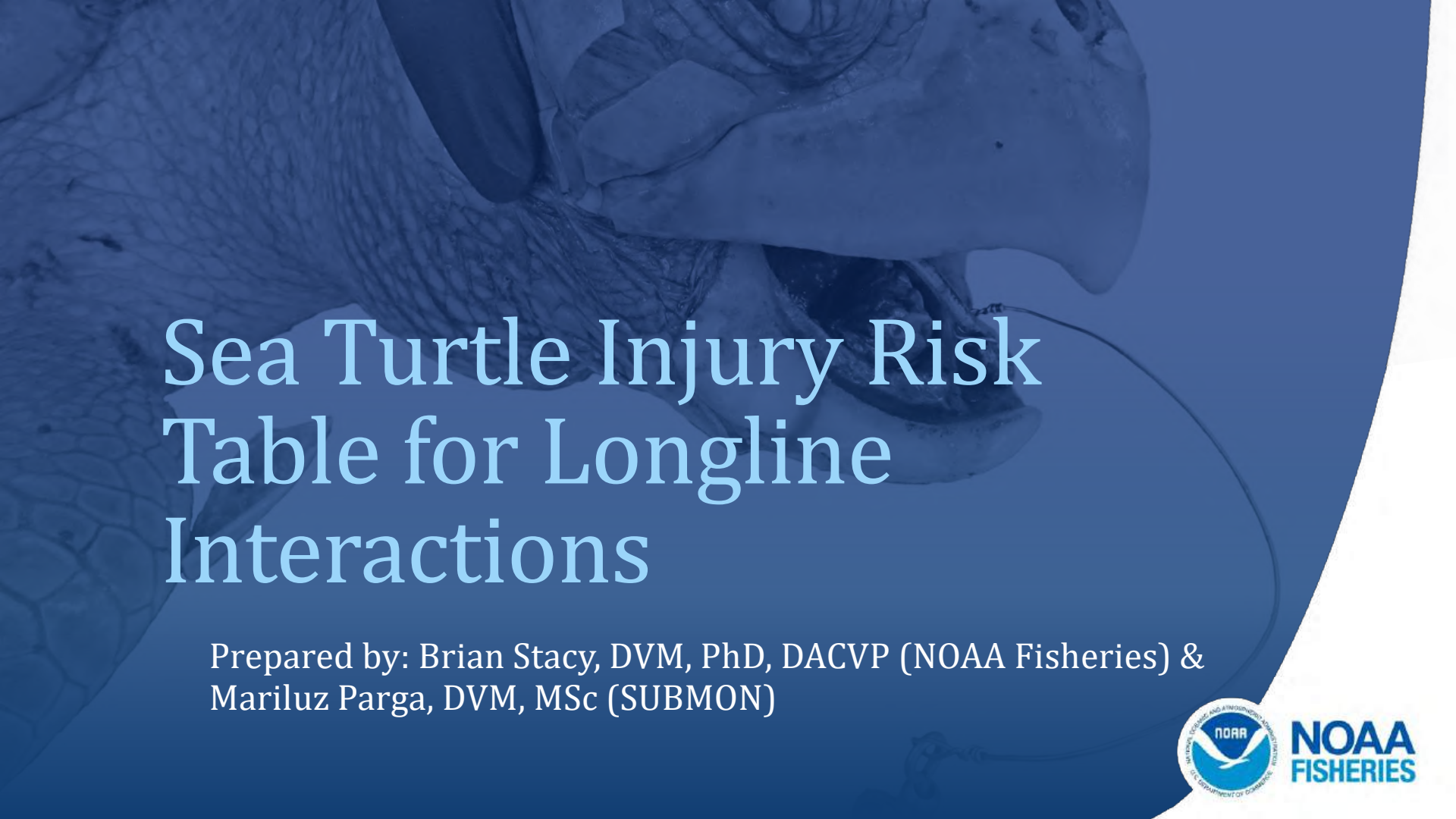

# Sea Turtle Injury Risk Table for Longline Interactions

Prepared by: Brian Stacy, DVM, PhD, DACVP (NOAA Fisheries) &
Mariluz Parga, DVM, MSc (SUBMON)

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# Overview

- Framework to compare relative risk to sea turtles across longline hook types, interaction scenarios, & mitigation options
- Based on veterinary opinion
- Intended as a tool to assist discussions & decision-making; not as a standalone management resource
- Specific scenarios, gear types, & comparisons may warrant modification

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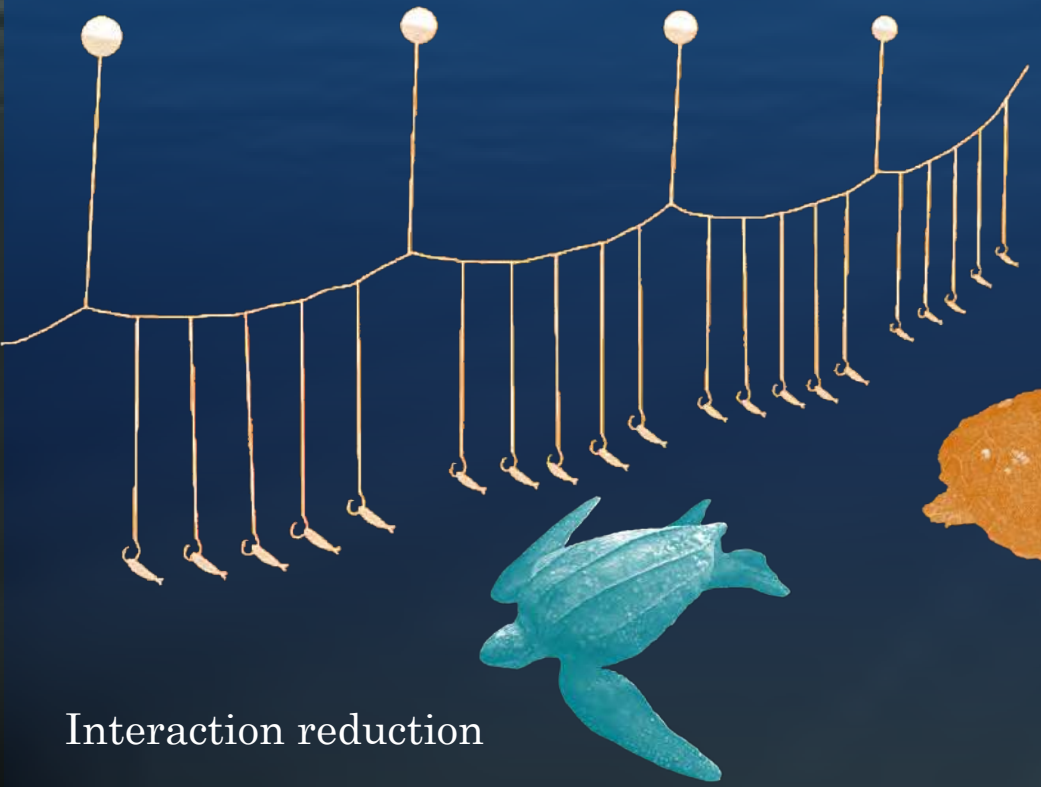
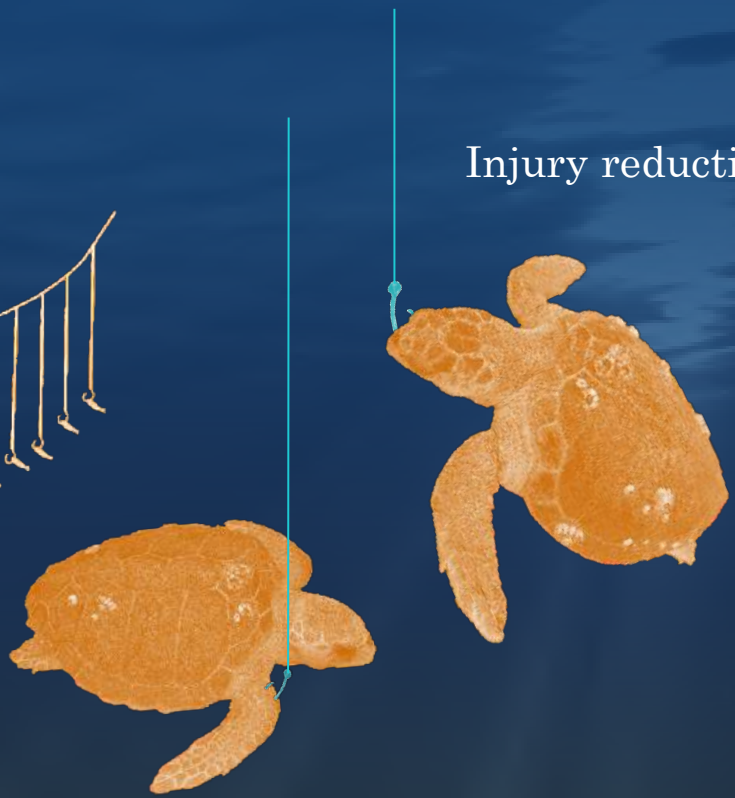
# Table description



Interaction reduction



Injury reduction

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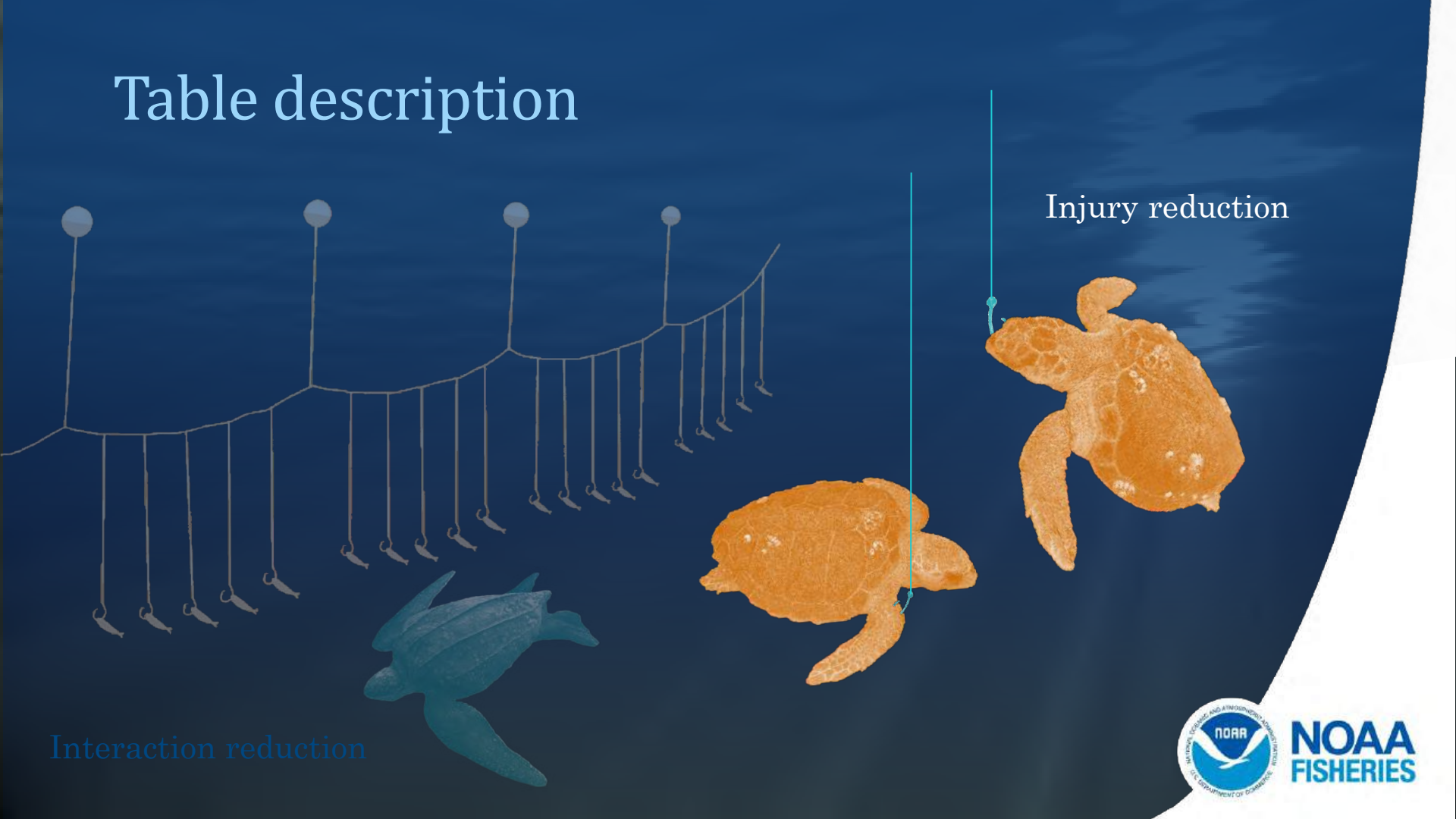
# Table description

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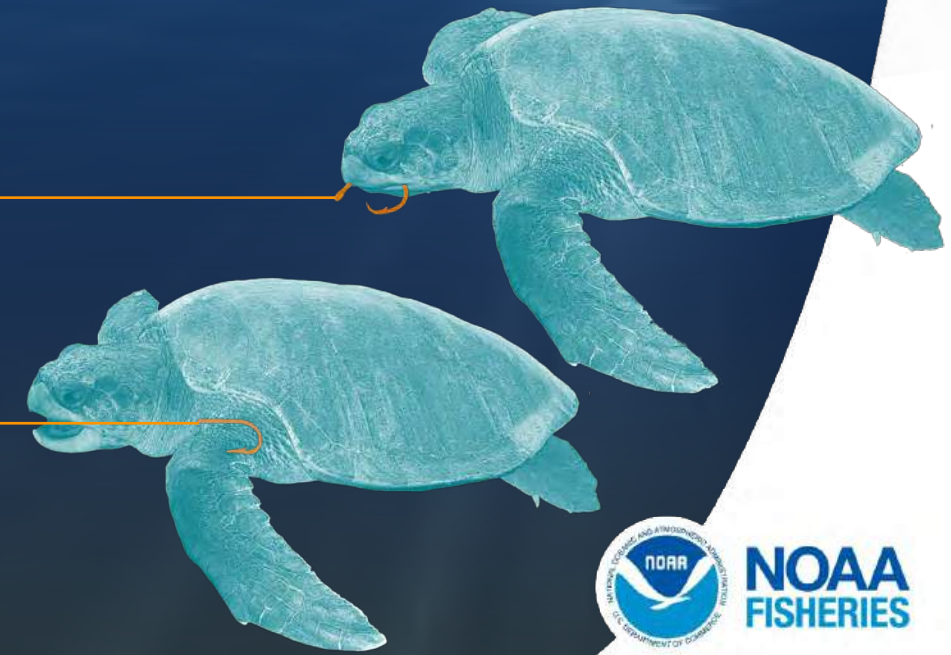
# “Relative risk” as applied in table

- Comparative likelihood of injury leading to immediate or delayed fatality.
  - Trauma during interaction,



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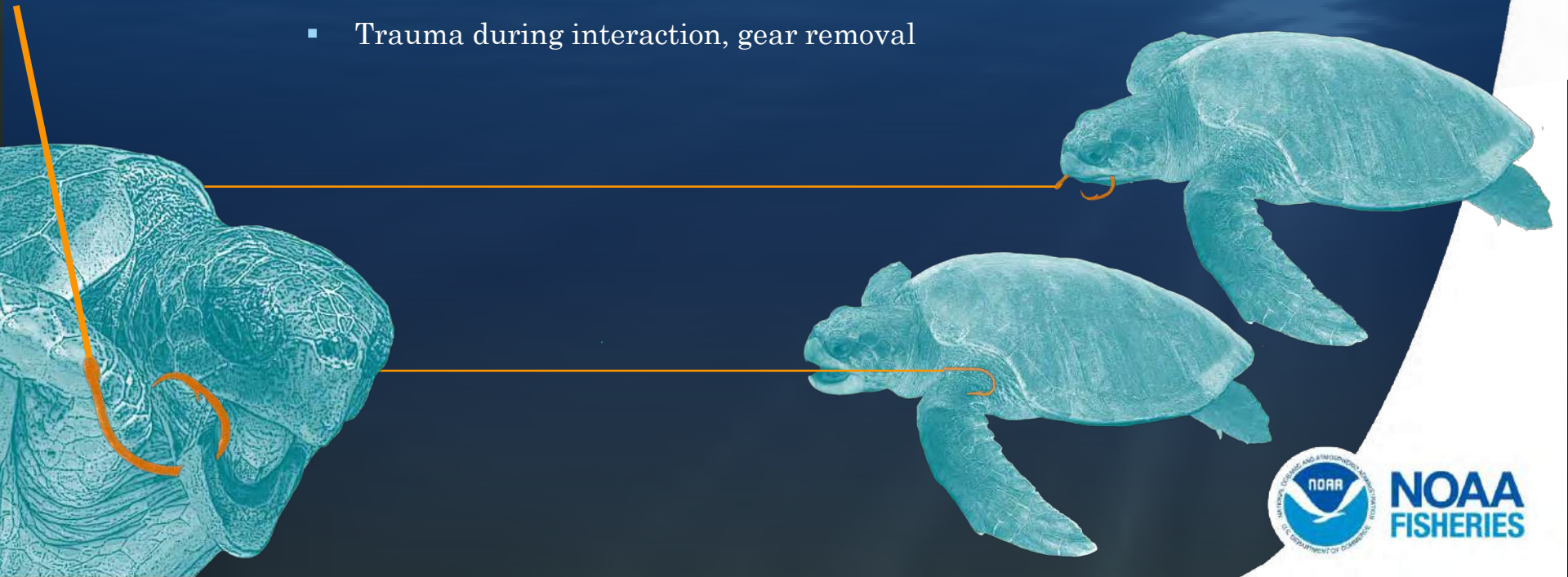
# “Relative risk” as applied in table

- Comparative likelihood of injury leading to immediate or delayed fatality.
  - Trauma during interaction, gear removal



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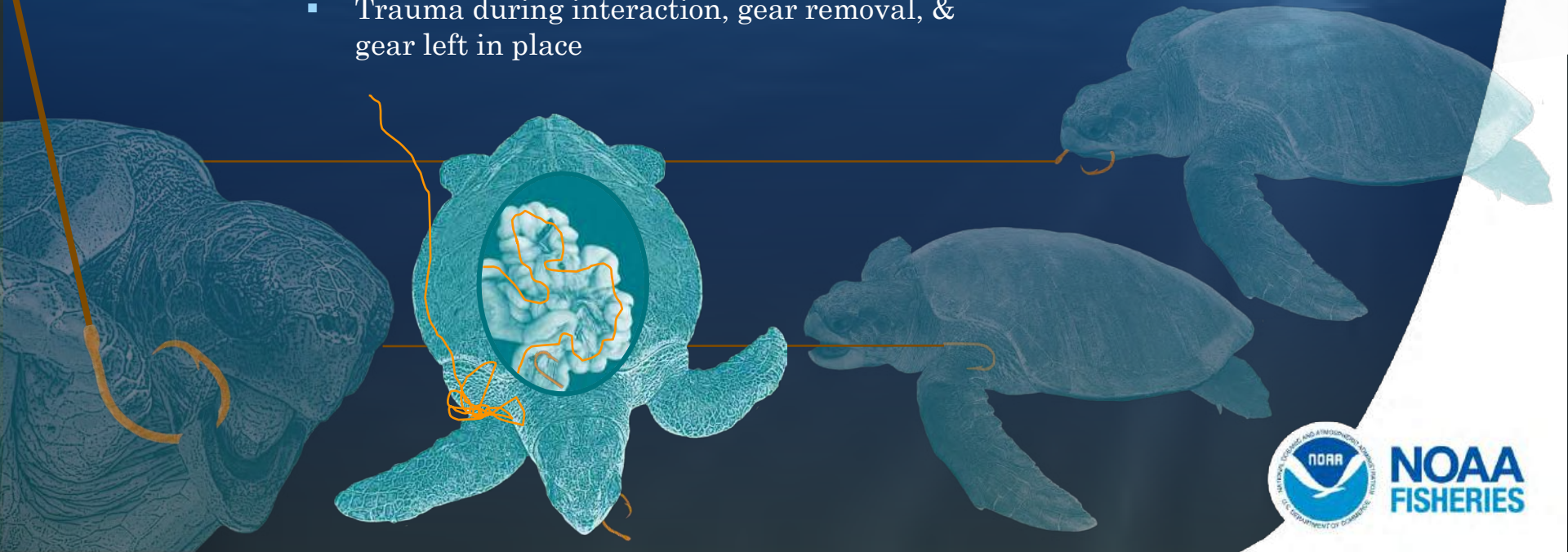
# “Relative risk” as applied in table

- Comparative likelihood of injury leading to immediate or delayed fatality.
  - Trauma during interaction, gear removal, & gear left in place



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# Important questions

- Are there anticipated differences in hooking location among the hook types/sizes under consideration?
  - *"Large" circle hook applied as ≥16/0 per Griffiths et al. 2024 (EASI-Fish): https://www.int-res.com/articles/esr2024/53/n053p271.pdf*
- What are the gear removal practices in the fishery, if any?
- How amenable are the physical properties of the hooks to removal tools & techniques?

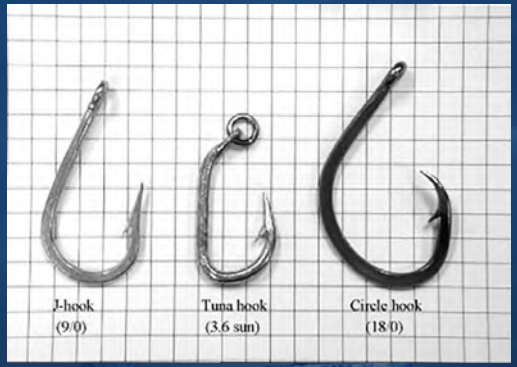


*Photo credit: Curran & Bigelow 2011*

*These factors are variable across fisheries & can have significant bearing on injury risks to bycaught sea turtles*

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# Injury risk scoring

**Risk score**

+3

+2

+1

+

**Confidence score**

+3

+2

+1

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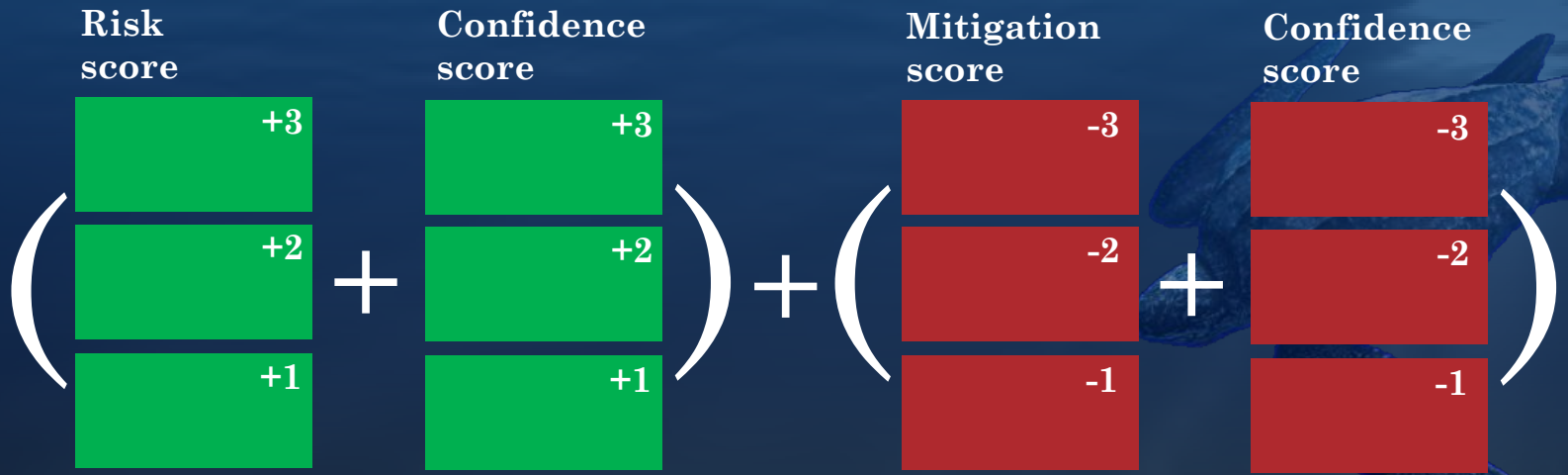
# Injury risk scoring

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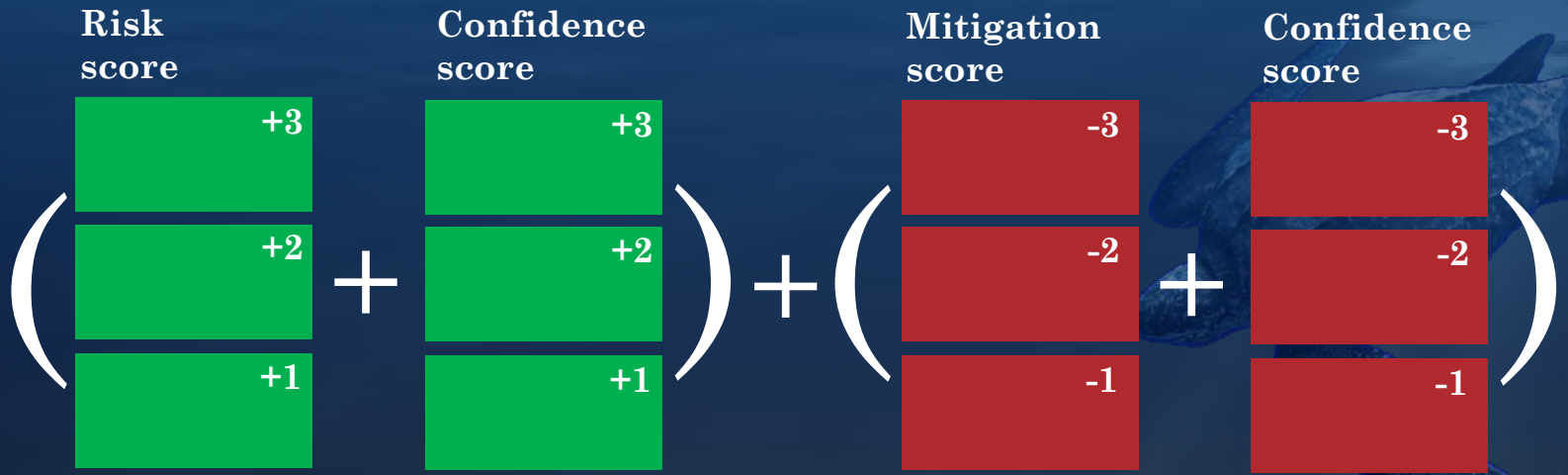
# Injury risk scoring




Lower the score = lower the risk

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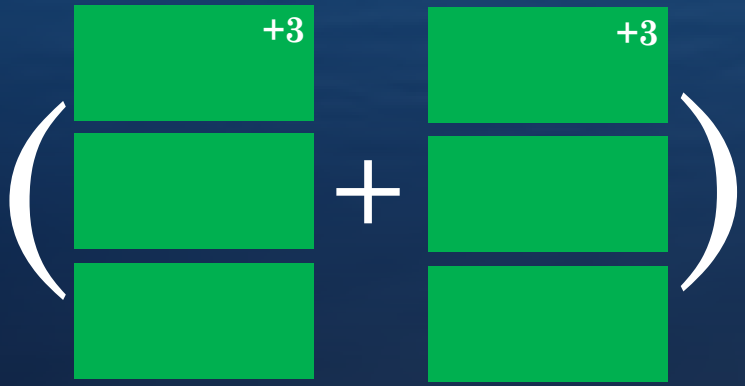
# Scoring example

**Risk score**

**Confidence score**




Factor is very injurious;
good quality supportive data

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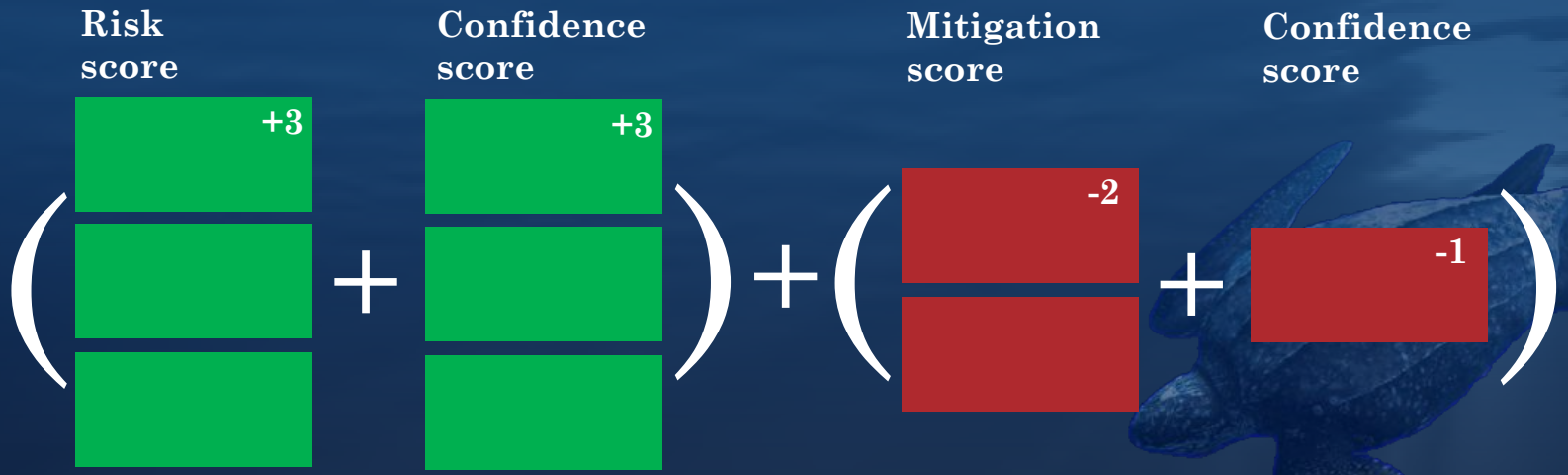
# Scoring example




Factor is very injurious; good quality supportive data

Moderate mitigation option; little supportive data on efficacy

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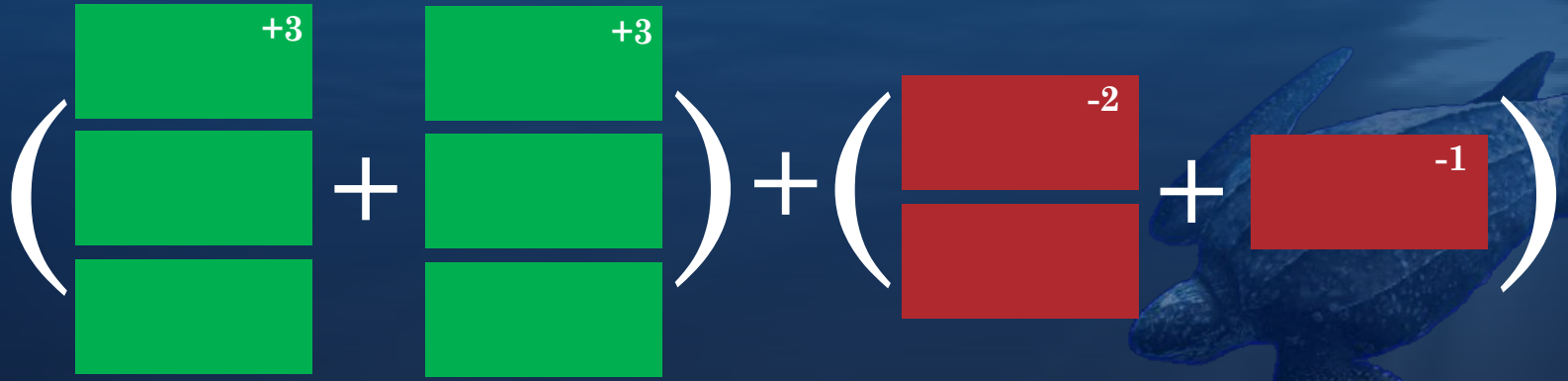
# Scoring example

**Risk score**

**Confidence score**

**Mitigation score**

**Confidence score**




Factor is very injurious; good quality supportive data

Moderate mitigation option; little supportive data on efficacy

=3

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| 1. Action / hook type | 2. Relative risk | 3. Benefit/risk assessment rationale | 4. Confidence in relative risk assessment | 5. Degree affected by mitigation action? | 6. Mitigation assessment rationale | 7. Confidence in mitigation efficacy | 8. Life stage / taxa considerations | 9. Score (Δ) |
|---|---|---|---|---|---|---|---|---|
| A. Retrieval to boat (injury primarily results from trauma caused by line tension and penetration or laceration of anatomical structures surrounding the hook location) | | | | | | | | |
| Circle hook | Low | Hook locations involving the oral cavity[1] pose less risk of fatal injury because of relative resiliency of the associated anatomy. | High. Injury resulting from swallowed hooks under tension well-evidenced from necropsy data (e.g., from recreational fishing interactions). | Low (Safe handling) | Some benefit, but safety during retrieval is inherent to hook location. | High. Measure doesn't rely on additional mitigation. | Risks higher for larger, heavier turtles. Less disparity in risk between hook types for foul-hooked interactions (e.g., leatherbacks). | 2 (Circle)[1] |
| J-hook | High | Greater risk of penetration or laceration of blood vessels or respiratory tract or major trauma to esophagus / stomach. | | High (Safe handling) | Can reduce injurious actions, such as lifting animals by line, boarding with nets, etc. | Low. Efficacy of implementation difficult to confirm, especially without concurrent robust observer programs. | | |
| T-hook | High | As for J-hooks. | | High (Safe handling) | As for J-hooks. | Low. As for J-hooks | | |
| B. Gear removal – complete removal of both hook and line (injury primarily results from trauma caused by penetration or laceration of anatomical structures surrounding the hook location) | | | | | | | | |
| Circle hook | Medium | Hooks that are not swallowed are more accessible and easier to remove without trauma to delicate or vital anatomy, but can injure the mouth or upper airway. | High. Injury resulting from traumatic removal of swallowed hooks well-evidenced from necropsy data (e.g., from recreational fishing interactions. | Medium (Safe handling) | Larger hooks are more difficult to cut and remove without injury, even with instruction. | Low· Efficacy of implementation difficult to confirm, especially without concurrent robust observer programs. | Less disparity in risk between hook types for foul-hooked interactions (e.g., leatherbacks). | 0[2] (None) |
| J-hook | High | Greater risk of penetration or laceration of blood vessels or respiratory tract or major trauma to esophagus / stomach during removal. | | High (Safe handling) | Improved safe handling can allow effective removal of non-swallowed gear and help avoid further injury by swallowed gear. | | | 1[3] (Circle) |
| T-hook | High | As for J-hooks. | | Medium (Safe handling) | Mitigation lower due to greater difficulty in safe removal associated with greater hook thickness and larger barbs. | | | |

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| 1. Action / hook type | 2. Relative risk | 3. Benefit/risk assessment rationale | 4. Confidence in relative risk assessment | 5. Degree affected by mitigation action? | 6. Mitigation assessment rationale | 7. Confidence in mitigation efficacy | 8. Life stage / taxa considerations | 9. Score (Δ) |
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| T-hook | High | As for J-hooks. | | High (Safe handling) | As for J-hooks. | Low. As for J-hooks | | |
| B. Gear removal – complete removal of both hook and line (injury primarily results from trauma caused by penetration or laceration of anatomical structures surrounding the hook location) | | | | | | | | |
| Circle hook | Medium | Hooks that are not swallowed are more accessible and easier to remove without trauma to delicate or vital anatomy, but can injure the mouth or upper airway. | High. Injury resulting from traumatic removal of swallowed hooks well-evidenced from necropsy data (e.g., from recreational fishing interactions. | Medium (Safe handling) | Larger hooks are more difficult to cut and remove without injury, even with instruction. | Low. Efficacy of implementation difficult to confirm, especially without concurrent robust observer programs. | Less disparity in risk between hook types for foul-hooked interactions (e.g., leatherbacks). | 0[2] (None) |
| J-hook | High | Greater risk of penetration or laceration of blood vessels or respiratory tract or major trauma to esophagus / stomach during removal. | | High (Safe handling) | Improved safe handling can allow effective removal of non-swallowed gear and help avoid further injury by swallowed gear. | | | 1[3] (Circle) |
| T-hook | High | As for J-hooks. | | Medium (Safe handling) | Mitigation lower due to greater difficulty in safe removal associated with greater hook thickness and larger barbs. | | | |

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Example comparison. Retrieval to boat (injury primarily results from trauma caused by line tension and penetration or laceration of anatomical structures surrounding the hook location)

**Circle hook**

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# Example comparison. Retrieval to boat (injury primarily results from trauma caused by line tension and penetration or laceration of anatomical structures surrounding the hook location)


| 1. Action / hook type | 2. Relative risk | 3. Benefit/risk assessment rationale | 4. Confidence in relative risk assessment |
|---|---|---|---|
| A. Retrieval to boat (injury primarily results from trauma caused by line tension… | | | |
| Circle hook | Low | Hook locations involving the oral cavity[1] pose less risk of fatal injury because of relative resiliency of the associated anatomy. | High. Injury resulting from swallowed hooks under tension well-evidenced from necropsy data (e.g., from recreational fishing interactions). |
| J-hook | High | Greater risk of penetration or laceration of blood vessels or respiratory tract or major trauma to esophagus / stomach. | |
| T-hook | High | As for J-hooks. | |

| 5. Degree affected by mitigation action? | 6. Mitigation assessment rationale | 7. Confidence in mitigation efficacy | 8. Life stage / taxa considerations |
|---|---|---|---|
| …and penetration or laceration of anatomical structures surrounding the hook location) | | | |
| Low (Safe handling) | Some benefit, but safety during retrieval is inherent to hook location. | High. Measure doesn't rely on additional mitigation. | Risks higher for larger, heavier turtles. Less disparity in risk between hook types for foul-hooked interactions (e.g., leatherbacks). |
| High (Safe handling) | Can reduce injurious actions, such as lifting animals by line, boarding with nets, etc. | Low. Efficacy of implementation difficult to confirm, especially without concurrent robust observer programs. | |
| High (Safe handling) | As for J-hooks. | Low. As for J-hooks | |

# Example comparison. Retrieval to boat.

| 1. Action / hook type | 2. Relative risk | 3. Benefit/risk assessment rationale | 4. Confidence in relative risk assessment |
|---|---|---|---|
| A. Retrieval to boat (injury primarily results from trauma caused by line tension… | | | |
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| J-hook | High | Greater risk of penetration or laceration of blood vessels or respiratory tract or major trauma to esophagus / stomach. | |
| T-hook | High | As for J-hooks. | |

| 5. Degree affected by mitigation action? | 6. Mitigation assessment rationale | 7. Confidence in mitigation efficacy | 8. Life stage / taxa considerations |
|---|---|---|---|
| …and penetration or laceration of anatomical structures surrounding the hook location) | | | |
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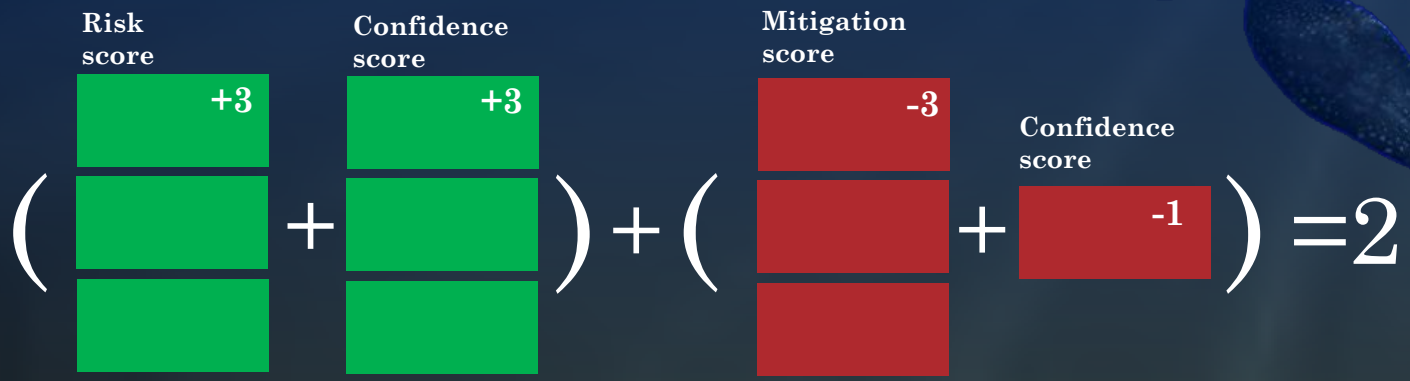
| High (Safe handling) | As for J-hooks. | Low. As for J-hooks | |

## J & T hook

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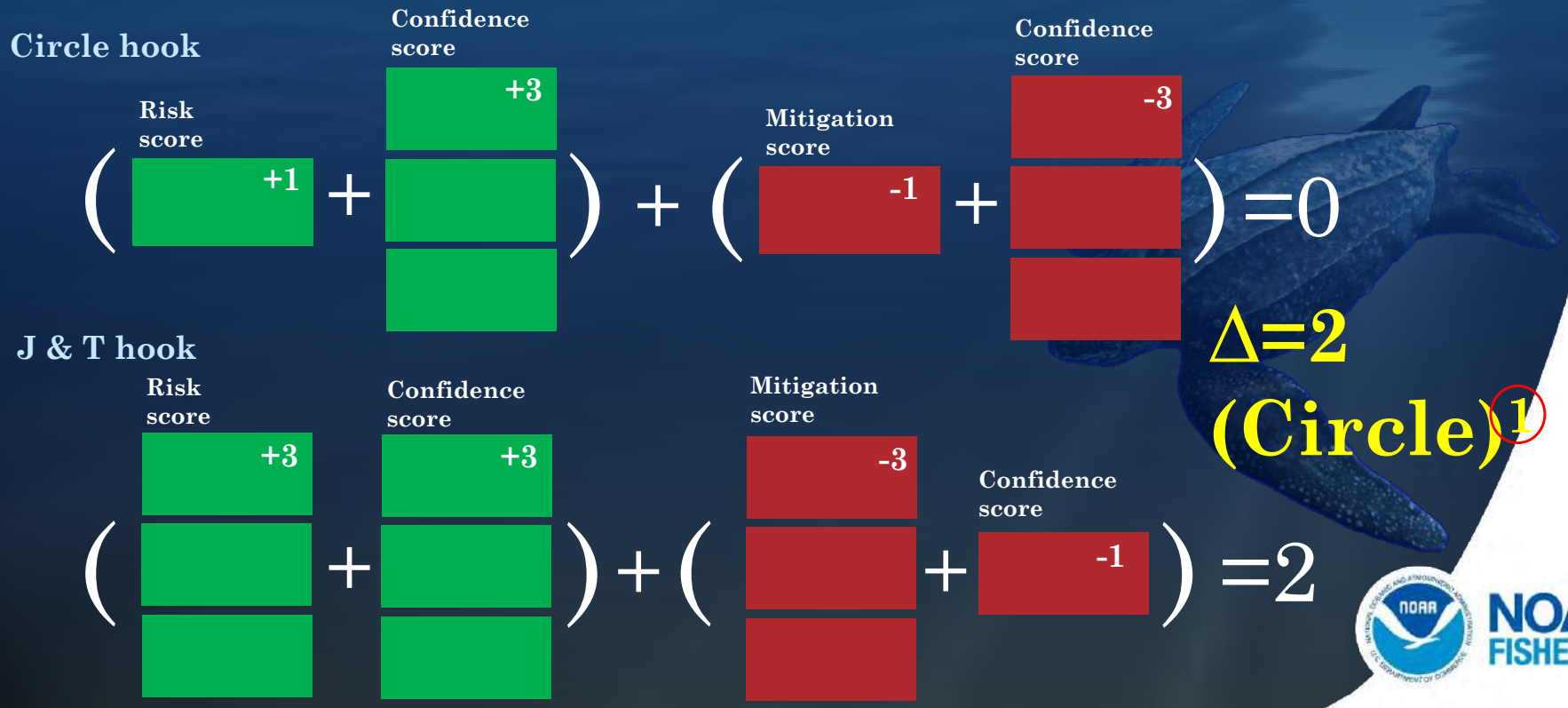
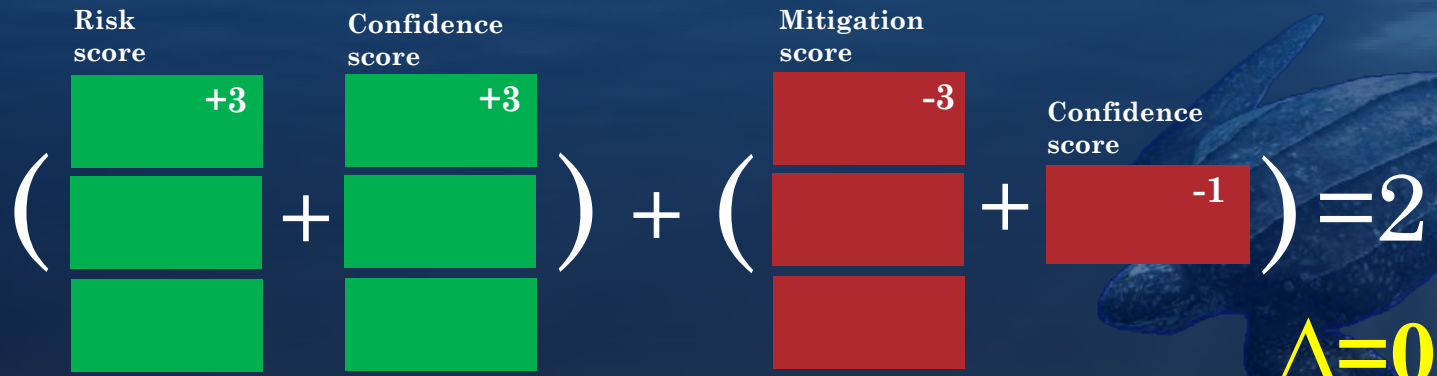
Example comparison. Retrieval to boat (injury primarily results from trauma caused by line tension and penetration or laceration of anatomical structures surrounding the hook location)



Example comparison. Retrieval to boat (injury primarily results from trauma caused by line tension and penetration or laceration of anatomical structures surrounding the hook location)

**Circle hook *(swallowed)***




Risk during retrieval to the boat is considered greater for any hooks or shapes that can be swallowed and penetrate visceral anatomy, as determined by the specific hook characteristics and morphology of the turtle species and size caught. For swallowed circle hooks, relative risk and confidence would be the same as for J- and T-hooks (score (Δ) of zero).

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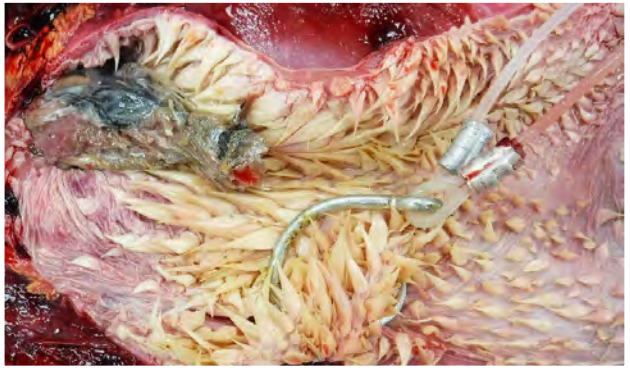
| 1. Action / hook type | 2. Relative risk | 3. Benefit/risk assessment rationale | 4. Confidence in relative risk assessment | 5. Degree affected by mitigation action? | 6. Mitigation assessment rationale | 7. Confidence in mitigation efficacy | 8. Life stage / taxa considerations | 9. Score (Δ) |
|---|---|---|---|---|---|---|---|---|
| B. Gear removal – complete removal of both hook and line (injury primarily results from trauma caused by penetration or laceration of anatomical structures surrounding the hook location) | | | | | | | | |
| Circle hook | Medium | Hooks that are not swallowed are more accessible and easier to remove without trauma to delicate or vital anatomy, but can injure the mouth or upper airway. | High. Injury resulting from traumatic removal of swallowed hooks well-evidenced from necropsy data (e.g., from recreational fishing interactions. | Medium (Safe handling) | Larger hooks are more difficult to cut and remove without injury, even with instruction. | Low· Efficacy of implementation difficult to confirm, especially without concurrent robust observer programs. | Less disparity in risk between hook types for foul-hooked interactions (e.g., leatherbacks). | 0[2] (None) |
| J-hook | High | Greater risk of penetration or laceration of blood vessels or respiratory tract or major trauma to esophagus / stomach during removal. | | High (Safe handling) | Improved safe handling can allow effective removal of non-swallowed gear and help avoid further injury by swallowed gear. | | | 1[3] (Circle) |
| T-hook | High | As for J-hooks. | | Medium (Safe handling) | Mitigation lower due to greater difficulty in safe removal associated with greater hook thickness and larger barbs. | | | |



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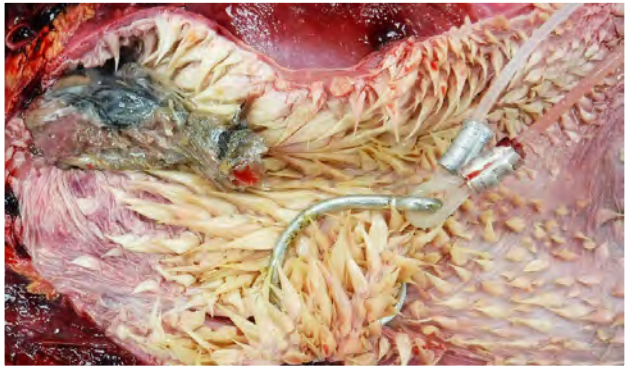
Circle vs J-hook

Circle vs T-hook



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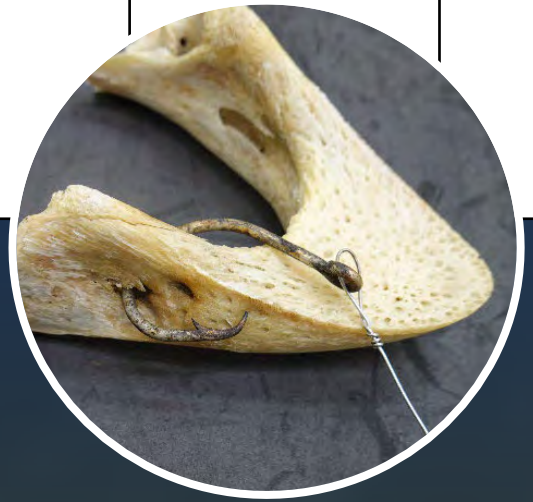
|---|---|---|---|---|---|---|---|---|
| C. Gear left in place – hook only or with attached line ≤ carapace length (ongoing trauma, secondary infection, internal encapsulation, or shedding of the hook) | | | | | | | | |
| Circle hook | Medium | The rate of hook degradation, even for ferrous materials, is slower than rate of injury, infection, healing of structures of the mouth required for feeding and respiration. | Low. Hooks within the oral cavity and swallowed have substantial, but somewhat different risks that are difficult to qualify based on available data. There is minimal data on long-term fate of oral hooks left in place. | Low (Safe handling) | There is no significant mitigation for hook ± short line left in place as risk largely occurs post-release. | High. No Post-release mitigation | Low risk with both hook types for foul-hooked interactions (e.g., leatherbacks). | 0[2] (None) 1[3] (Circle) |
| J-hook | Medium | Some published observations in hooks naturally shed from the digestive tract and observations of encapsulated hooks without fatal complication in some proportion of cases. | | | | | | |
| T-hook | High | Higher risk based on their larger barb size and potential injury when left in place. | | | | | | |



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Circle vs J-hook

Circle vs T-hook

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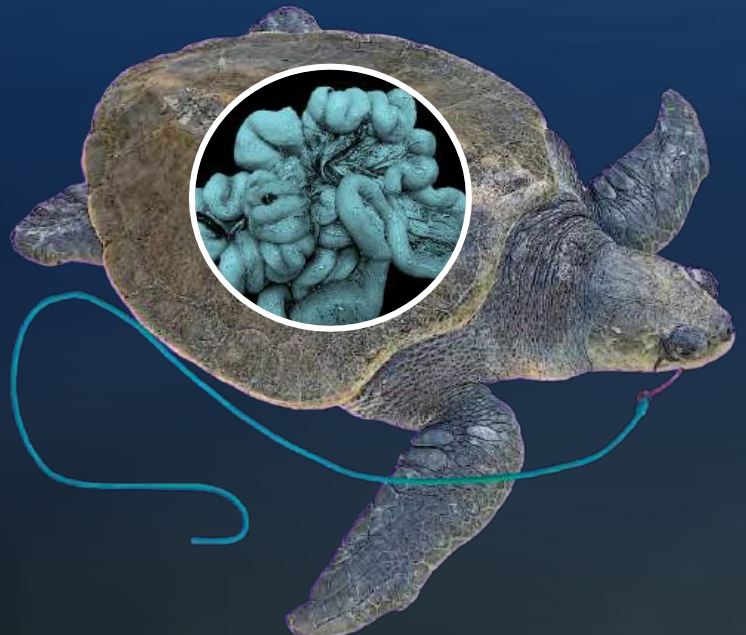
| 1. Action / hook type | 2. Relative risk | 3. Benefit/risk assessment rationale | 4. Confidence in relative risk assessment | 5. Degree affected by mitigation action? | 6. Mitigation assessment rationale | 7. Confidence in mitigation efficacy | 8. Life stage / taxa considerations | 9. Score (Δ) |
|---|---|---|---|---|---|---|---|---|
| D. Gear left in place – hook with line ≥ carapace length (persistent risk of entanglement and ingestion resulting in GI injury/obstruction) | | | | | | | | |
| All hook types | High | Higher frequency of delayed mortality attributed to fishing line as compared to hooks. | High. No obvious difference in hook type due to greater risk attributed to fishing line. | Low (Safe handling) | There is no significant mitigation for hook with lengthy line left in place as risk largely occurs post-release. | High. No post-release mitigation | None | 0 (None) |



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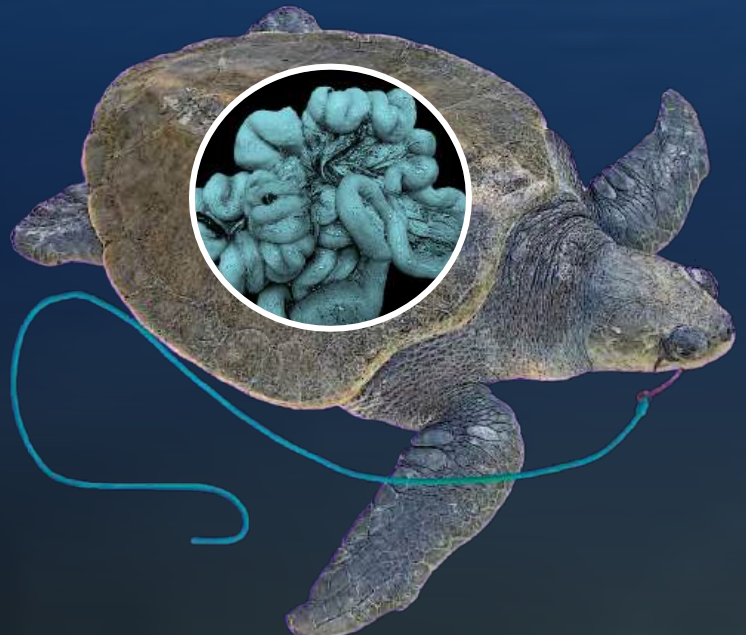

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# Risk assessment key points

- Confident differences:
  - lower overall risk in foul-hooked vs. hooks in mouth or swallowed (especially with line/gear removal)
  - lower risk of injury during gear hauling/handling for hooks in mouth vs. swallowed
- Less confident differences:
  - risk of injury during gear removal
  - injury caused by gear left on/in turtles

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# Summary

- Principal advantages of circle hooks for sea turtles are:
  1. Reduction in bycatch (interaction)
  2. Potential reduction of injury risk during & post-interaction in some circumstances
- Assessment of relative risk following interaction requires careful consideration of:
  - Hook characteristics available/suitable for fishery
  - Species/size of bycaught turtles
  - Animal handling/gear removal practices & feasibility

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# ¿Questions?

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| 1. Action / hook type | 2. Relative risk | 3. Benefit/risk assessment rationale | 4. Confidence in relative risk assessment | 5. Degree affected by mitigation action? | 6. Mitigation assessment rationale | 7. Confidence in mitigation efficacy | 8. Life stage / taxa considerations | 9. Score (Δ) |
|---|---|---|---|---|---|---|---|---|
| A. Retrieval to boat (injury primarily results from trauma caused by line tension and penetration or laceration of anatomical structures surrounding the hook location) | | | | | | | | |
| Circle hook | Low | Hook locations involving the oral cavity[1] pose less risk of fatal injury because of relative resiliency of the associated anatomy. | High. Injury resulting from swallowed hooks under tension well-evidenced from necropsy data (e.g., from recreational fishing interactions). | Low (Safe handling) | Some benefit, but safety during retrieval is inherent to hook location. | High. Measure doesn't rely on additional mitigation. | Risks higher for larger, heavier turtles. Less disparity in risk between hook types for foul-hooked interactions (e.g., leatherbacks). | 2 (Circle)[1] |
| J-hook | High | Greater risk of penetration or laceration of blood vessels or respiratory tract or major trauma to esophagus / stomach. | | High (Safe handling) | Can reduce injurious actions, such as lifting animals by line, boarding with nets, etc. | Low. Efficacy of implementation difficult to confirm, especially without concurrent robust observer programs. | | |
| T-hook | High | As for J-hooks. | | High (Safe handling) | As for J-hooks. | Low. As for J-hooks | | |
| B. Gear removal – complete removal of both hook and line (injury primarily results from trauma caused by penetration or laceration of anatomical structures surrounding the hook location) | | | | | | | | |
| Circle hook | Medium | Hooks that are not swallowed are more accessible and easier to remove without trauma to delicate or vital anatomy, but can injure the mouth or upper airway. | High. Injury resulting from traumatic removal of swallowed hooks well-evidenced from necropsy data (e.g., from recreational fishing interactions. | Medium (Safe handling) | Larger hooks are more difficult to cut and remove without injury, even with instruction. | Low· Efficacy of implementation difficult to confirm, especially without concurrent robust observer programs. | Less disparity in risk between hook types for foul-hooked interactions (e.g., leatherbacks). | 0[2] (None) |
| J-hook | High | Greater risk of penetration or laceration of blood vessels or respiratory tract or major trauma to esophagus / stomach during removal. | | High (Safe handling) | Improved safe handling can allow effective removal of non-swallowed gear and help avoid further injury by swallowed gear. | | | 1[3] (Circle) |
| T-hook | High | As for J-hooks. | | Medium (Safe handling) | Mitigation lower due to greater difficulty in safe removal associated with greater hook thickness and larger barbs. | | | |

Extra slides for ease of reference

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|---|---|---|---|---|---|---|---|---|
| C. Gear left in place – hook only or with attached line ≤ carapace length (ongoing trauma, secondary infection, internal encapsulation, or shedding of the hook) | | | | | | | | |
| Circle hook | Medium | The rate of hook degradation, even for ferrous materials, is slower than rate of injury, infection, healing of structures of the mouth required for feeding and respiration. | Low. Hooks within the oral cavity and swallowed have substantial, but somewhat different risks that are difficult to qualify based on available data. There is minimal data on long-term fate of oral hooks left in place. | Low (Safe handling) | There is no significant mitigation for hook ± short line left in place as risk largely occurs post-release. | High. No Post-release mitigation | Low risk with both hook types for foul-hooked interactions (e.g., leatherbacks). | 0[2] (None) 1[3] (Circle) |
| J-hook | Medium | Some published observations in hooks naturally shed from the digestive tract and observations of encapsulated hooks without fatal complication in some proportion of cases. | | | | | | |
| T-hook | High | Higher risk based on their larger barb size and potential injury when left in place. | | | | | | |
| D. Gear left in place – hook with line ≥ carapace length (persistent risk of entanglement and ingestion resulting in GI injury/obstruction) | | | | | | | | |
| All hook types | High | Higher frequency of delayed mortality attributed to fishing line as compared to hooks. | High. No obvious difference in hook type due to greater risk attributed to fishing line. | Low (Safe handling) | There is no significant mitigation for hook with lengthy line left in place as risk largely occurs post-release. | High. No post-release mitigation | None | 0 (None) |



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