Coral Reef CSI Toolkit

A Guide for Coral Reef Managers & Investigators

Dave Gulko • Ken Goddard • Patricia Ramírez-Romero • Angelique Brathwaite • Nicola Barnard

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ICRAN
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"Incidunt quis, vulputate sit amet, placerat vitae, mass amet, placerat vitae, massa."[1]

This work is part of a multi-faceted training program developed to train coral reef resource managers, enforcement officers, litigators, researchers, and NGOs in the field of underwater natural resource impact investigation using standardized tools and techniques adopted by the International Coral Reef Initiative (ICRI). For more information please visit http://www.icriforum.org.

Acknowledgements:

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[1] From the Latin phrase, roughly translated as: *"a true investigator always looks behind the words and does not immediately accept someone else's translation, especially when it's in Latin."*

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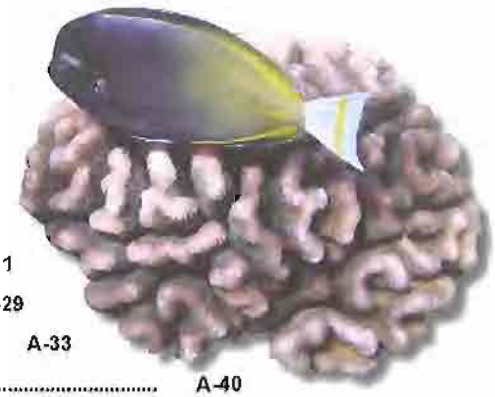

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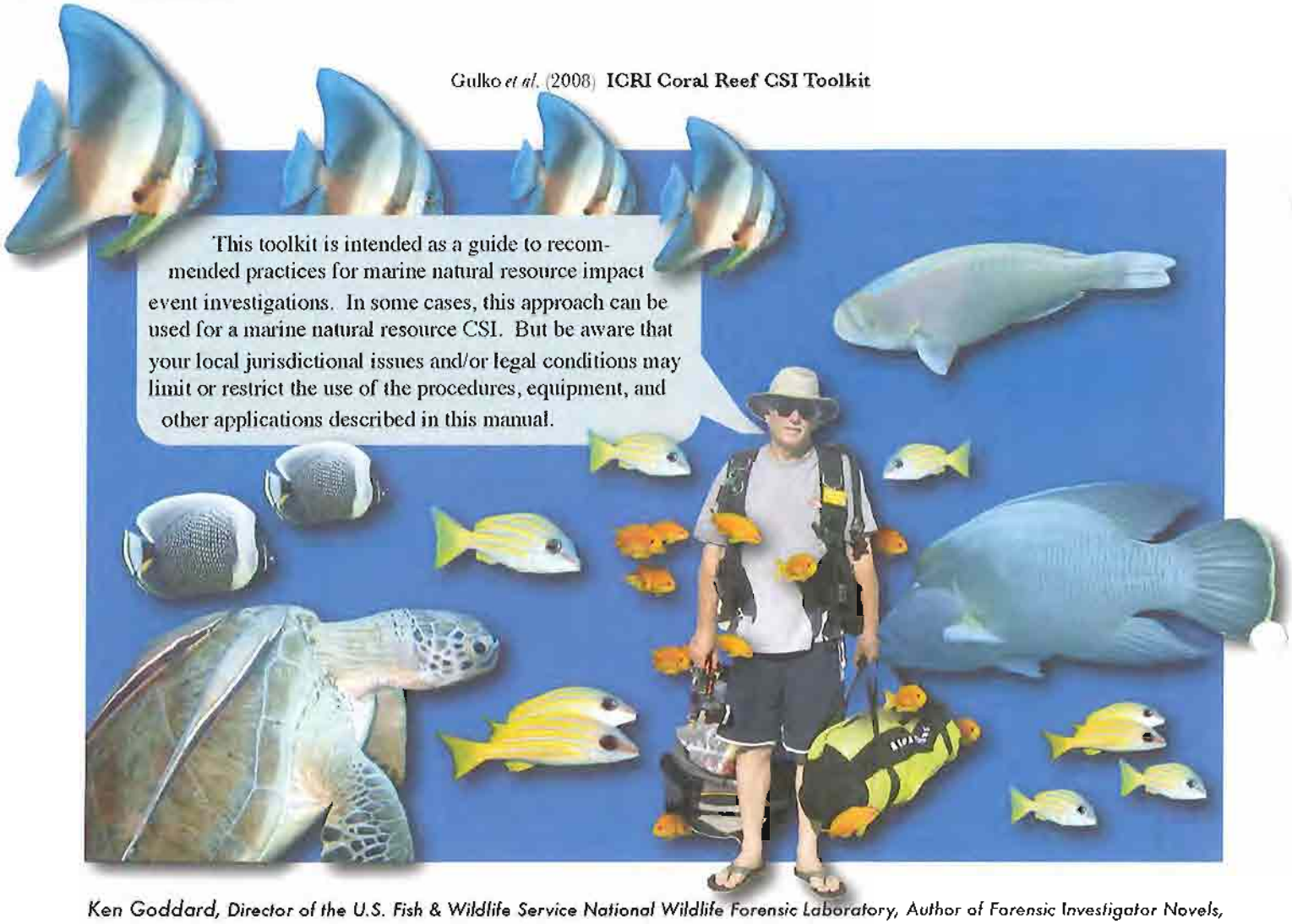
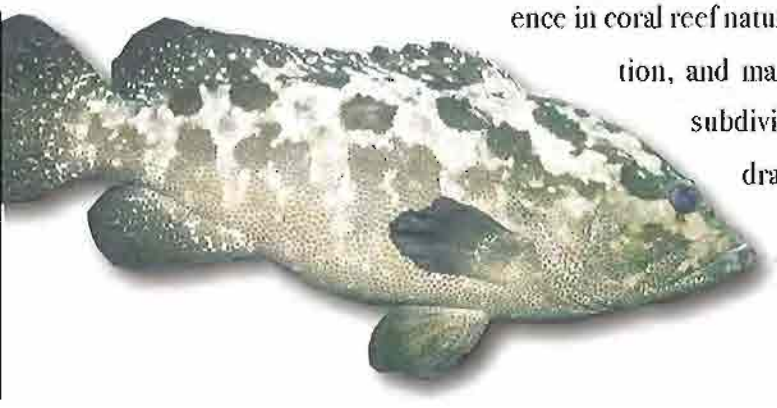


Ken Goddard, Director of the U.S. Fish & Wildlife Service National Wildlife Forensic Laboratory, Author of Forensic Investigator Novels, Advisor to the TV show "CSI", ex-homicide crime scene investigator, and one of the founding fathers of the field of Coral Reef CSI.

This toolkit is the product of a variety of people's hard work and effort which started back in late 2005 at the first International Marine Protected Areas Congress (IMPAC) where one of the key themes was Effective Management, which included a well-received session on Enforcement. As a result of the presentations and discussions on the topic of marine enforcement, several congress participants suggested forming an international effort to promote capacity building in the area of marine enforcement and natural resource investigations geared towards coral reef ecosystems. Shortly afterwards, both the International Coral Reef Initiative (ICRI) and the U. S. Coral Reef Task Force (USCRTF) formally resolved to support this effort. ICRI created a Committee on Coral Reef Enforcement and Natural Resource Investigation to expressly facilitate its occurrence. The ICRI Committee was made up of over 18 representatives representing 14 countries and islands, many of whom had extensive experience in coral reef natural resource management, marine resource impact investigation, and marine natural resource enforcement. The ICRI Committee subdivided into an active working group which produced a early draft toolkit, conducted a pilot field training workshop on



Coral Reef CSI and held a series of short symposia centered around the theme of Coral Reef Enforcement and Investigation at the 2006 International Tropical Marine Ecosystems Management Symposium (ITMEMS) in Cozumel, Mexico in an effort to produce a series of internationally-accepted protocols and standards for conducting investigations of short-term human impacts on coral reef resources. The combined and refined results of these efforts have been put together in this toolkit.

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Dave Gulko	Led the development and design for this project. A marine natural resource manager and coral reef ecologist with the State of Hawai'i, he is the lead biologist for the State of Hawai'i involved in coral reef natural resource investigations. Dave is currently the Lead of the International Coral Reef Initiative's Committee on Coral Reef Enforcement and Natural Resource Investigations. He is also an accomplished international marine natural history author who has produced a large volume of marine educational and resource management materials relating to coral reefs, and conducted numerous professional instructor trainings over his twenty-five years in the field.	

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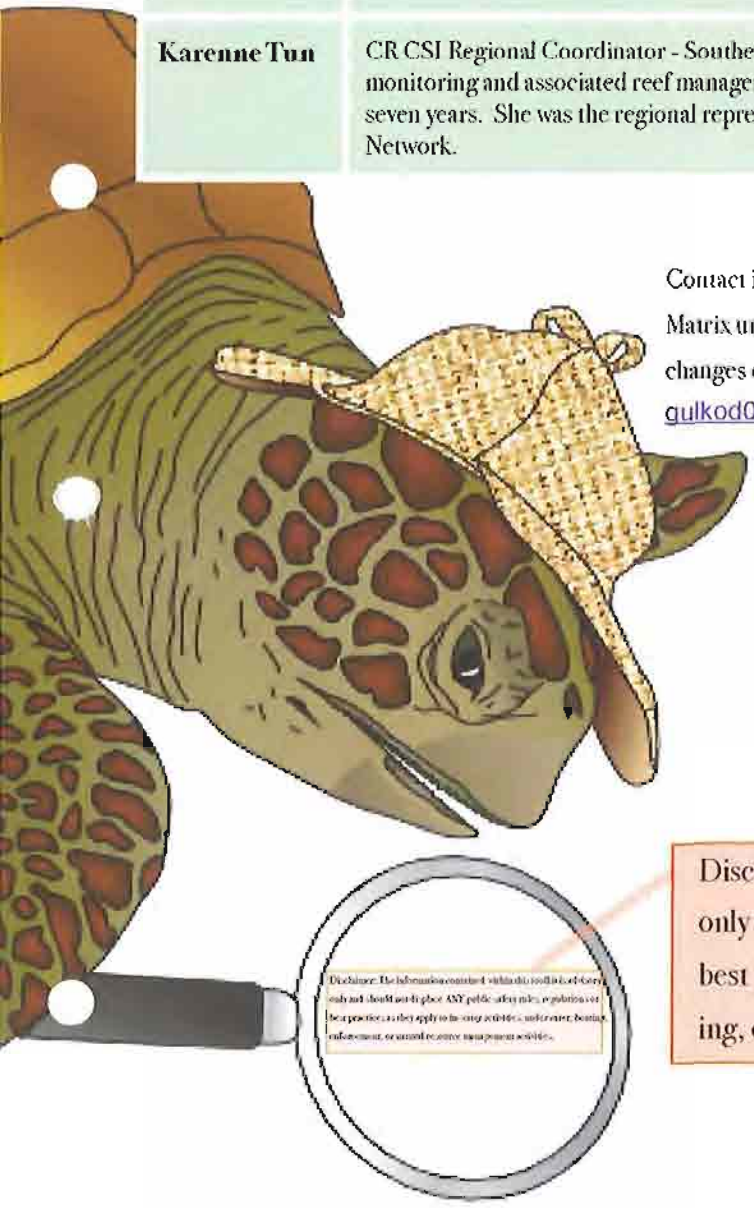


Contact information for each of the authors is listed within the International Expert Matrix under Appendix C. To contact the primary authors regarding any necessary changes or suggestions, please direct correspondence to Dave Gulko at gulkod001@hawaii.rr.com.

IMPORTANT NOTE: The material in this toolkit is designed to be used as part of a professional field training course and is not meant to be used by individuals who have not gone through formal training in its use.

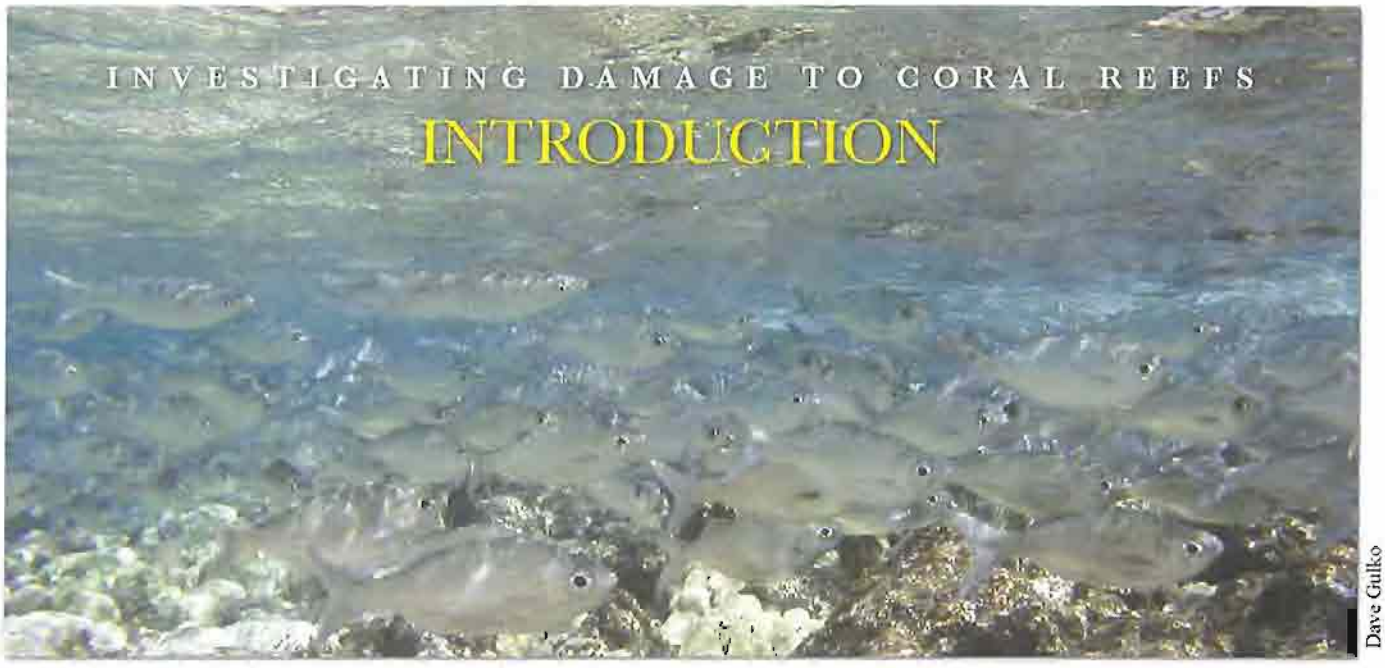
Disclaimer: The information contained within this toolkit is advisory only and should not displace ANY public safety rules, regulations or best practices as they apply to in-water activities, underwater, boating, enforcement, or natural resource management activities.

INVESTIGATING DAMAGE TO CORAL REEFS

A

Investigating Damage to Coral Reefs

Sections



Dave Gulko

Regardless of region, most coral reef ecosystems around the world are under various levels of impact from illegal fishing, vessel groundings, destructive fishing, physical damage, coastal pollution and runoff, overfishing, illegal international trade, over-lapping (and often conflicting) use by various user groups, bleaching, chemical effects and endocrine disruption, alien species-associated phase shifts, and nutrient-associated phase shifts. Few areas have trained field investigators and well-developed natural resource programs to properly assess and handle the wide variety of anthropogenic events occurring; in most cases, such short-term human impact events often overwhelm the capabilities of resource managers to maximize prosecution, mitigation, negotiation, mediation, or litigation success. This takes on even greater significance relative to multi-country joint-investigations relative to shared coral reef impacts and illegal trafficking in coral reef products.

While legal systems and resource management strategies vary from country to country, and island to island; successful investigation strategies related to coral reef anthropogenic events are relatively limited, and as yet, unstandardized at the most basic levels. Recently, groups of recognized experts, both in the United States (The Coral Disease and Health Consortium's Forensics Workshop Committee) and internationally (the International Coral Reef Initiative (ICRI) Committee on Coral Reef Enforcement and Natural Resource Investigation), have proposed initiating projects to create such standards. Such a project, making use of both investigative and rapid ecological assessment techniques, marine evidence collection methods and handling, and education of both the public and decision-makers will enhance both resource protection and management capabilities. This toolkit is the result of those efforts.



The Language of Injury Investigation

Throughout this toolkit certain terms will be used repetitively and are used around the world by professionals who investigate marine injuries. While individual definitions may vary by jurisdiction dependent upon legal statutes and authorities, the general definitions below will be used for this toolkit. Other terms are defined in the Glossary (Appendix E).

Chain of Custody: A process used to maintain and document the controlled possession of physical evidence, so that no one can alter, switch or change the evidence without detection.

Control or Reference Site: A site that is composed of the same habitat or subhabitat type, at the same depth, and under similar water regimes as the injured site being studied.

Damage Pathway: Shows the route(s) through which injury occurred at an injury site.

Documentation: Written notes, audio/videotapes, printed forms, sketches and/or photographs that form a detailed record of the scene, evidence recovered, and actions taken during the search of the underwater impact scene.

Evidence Identifiers: Tape, labels, containers, and string tags used to identify the collected evidence, the person collecting the evidence, the date the evidence was gathered, basic event/impact information, and a brief description of the pertinent evidence.

Impact Event Perimeter: The immediate area around an existing injury source (examples: a spill zone, the area immediately around a grounded vessel, etc.).

Natural Resource Trustee (NRT): Any entity with delegated authority to legally manage, protect, and regulate sovereign natural resources and/or habitats in a specified area. Trustees usually claim jurisdiction over an injury location or affected resource.

Responsible Party (RP): A term referring to the individuals, owners, or company which bear legal accountability for the resource injury. When a RP has not been clearly identified (or self-identified), the term **Potential Responsible Party (PRP)** can be used.

Primary Impact Event: The initial injury event (for example a vessel grounding); often, but not always, the largest event at an impact site, and usually the one that resulted in any follow-on events at the site.

Secondary Impact Event: The follow-on impact events (for example the response boats that pull a grounded vessel off the reef and cause additional damage). While there usually is only one primary event, there can be multitudes of secondary ones.

Standard Operating Procedures (SOPs): A preagreed upon set of rules for how a team performs its tasks and under what conditions it operates.

What's a Coral Reef Injury?

The physical, chemical, biological, and ultimately ecological damage that results from short-term human caused impacts in, on, or around coral reefs can form the basis of most natural resource injury investigations.

Coral reef injuries may involve an ever-increasing combination of damage forms, including direct and indirect injury to the reef flora and fauna (both sessile forms such as sponges, octacorals, bivalves, crustose coralline algae, and mobile forms such as crabs, lobsters, conch, fishes and sea turtles), reef framework injuries (breaking, smashing, fracturing, over-turning crushing and/or burial of coral colonies or underlying reef substrate), alien species introductions, and water quality effects. The resulting loss of biological and physical resources can have serious effects on coral reef ecosystem function, and can extend far beyond the immediate reef habitat to encompass adjacent marine and coastal habitats and subhabitats.

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Dave Gulko

- Organism Injury
- Population Injury
- Species Injury
- Community Injury
- Habitat Injury
- Ecosystem Injury

Response To A Coral Reef Injury?

For a given injury event, the Natural Resource Trustees (NRTs) are immediately confronted with a number of critical questions (What, Where, Who, How, Why, Identify) which need to be quickly addressed:

These Are The Questions You Ask During An Injury Event:

1. What is it (What caused the injury)?
2. Where is it (Specific location, size of injury)?
3. Who will it effect (Public safety concerns, user group displacement, resources at-risk)?
4. How will it impact natural resources or uses (Negative impact effects)?
5. What can be done (Immediately - response & emergency restoration; Later - compensatory mitigation and on-site restoration)?
6. Why did it happen (Enforcement concerns, NRT management, lessons learned)?
7. Identify All Endpoints (Costs, Resources, Recovery)?

The International Coral Reef Initiative ICRI

The International Coral Reef Initiative emerged out of the recognition that the coral reefs and related ecosystems found in tropical and sub-tropical regions are facing serious degradation, primarily due to anthropogenic stresses. Damaged or destroyed reefs can be found in more than 93 countries, with the coral reefs in South and Southeast Asia, East Africa and the Caribbean facing the greatest risk. It has been recognized that, if allowed to continue, this decline is likely to lead to the loss of most of the world's reef resources during this century.

The international scientific community has been focusing the public attention on the serious decline of reefs for some years. Eventually, the concept of a Coral Reef Initiative to provide a focus on the plight of reefs and on the actions necessary to reverse the trend of degradation emerged at various international meetings in the 1990s. It was founded on the clear recognition that many nations face similar threats to coral reefs and related ecosystems as well as similar management problems.

ICRI objectives call for:

1. Governments and international organizations strengthening commitment to and implementation of programs at the local, national, regional, and international levels to conserve, restore and promote sustainable use of coral reefs and associated environments;
2. Each country and region incorporating into existing local, regional, and national development plans, management provisions for protection, restoration, and sustainable use of the structure, processes, and biodiversity of coral reefs and associated environments;
3. Strengthening capacity for development and implementation of policies, management, research, and monitoring of coral reefs and associated environments;
4. Establishing and maintaining coordination of international, regional and national research and monitoring programs, to ensure efficient use of scarce resources and a flow of information relevant to management of coral reefs and associated environments.

ICRI is a unique environmental partnership that brings the stakeholders together with the objective of the conservation and sustainable use of coral reefs for

future generations. ICRI is an informal mechanism that allows representatives of governments, international organizations, conservation non-governmental organizations, scientific associations, and the private sector to consider the best strategies to conserve the world's coral reef resources.

ICRI is not a permanent structure or organization, but an informal network that aims to catalyze the best strategies to conserve coral reefs and related coastal resources in the tropics. ICRI does not develop and fund proposals, but ensures that the needs of the developing world concerning their coral reefs are conveyed to operational and funding organizations.

The ICRI Committee on Coral Reef Enforcement & Investigation

In late 2005, ICRI created a Committee on Coral Reef Enforcement and Investigation to address needs of member countries and associations relative to best management practices and training in in-water investigatory methods. The group was tasked to develop a training program on conducting in-water coral reef enforcement and natural resource investigations, which can be adapted for use in any major coral reef region. In large part, this training program was to be centered around a multi-layered toolkit (what you are holding in your hands) made up of teaching modules on various aspects of coral reef investigation techniques and protocols. Types of investigation training would include techniques applicable to vessel groundings; destructive fishing, illegal take, oil, chemical & sediment spills; pollution events including eutrophication; aquatic invasive species; and chronic sublethal events.

The primary focus of the toolkit will be to train coral reef resource managers, environmental assessment specialists, forensic investigators and litigators on conducting coral reef enforcement and natural resource field investigations. Hands-on training to accompany the toolkit will result in regional rapid response investigative capability being available for coordinated regional response efforts by resource managers who have gone through the regional training workshops using the toolkit.

The results of these efforts will be the training of key individuals within each coral reef country in the international protocols being developed for conducting defensible investigations of marine natural resource impacts on coral reefs to determine responsible parties, mitigative strategies and gather evidence for decision-making specifically tailored to their regional coral reef issues and concerns. Over the long term we expect to see increased capacity within each country's marine resource management and enforcement efforts, specifically as it relates to improved investigative capacity leading to increased success in prosecution, mediation, mitigation, restoration or litigation; along with greater public education and support resulting from these successes. We also envision greater regional multi-country cooperation involving investigations and rapid response capabilities, including formation of regional rapid response teams to deal with large-scale and multi-country marine natural resource impact investigations.

Stages of a Coral Reef CSI Field Investigation:

FIELD INVESTIGATION PHASES	PRIMARY ACTIVITIES	TIMELINE RELATIVE TO IMPACT EVENT	DAMAGE TIMELINE
Initiate Investigation (REPORT)	• Collect Incident Location and Other Parameters Information • Deploy Field Team	Immediately After Impact is Reported	1° Impact Damage and Peripheral
The Pre-Assessment (RESPOND)	• Set Event Perimeter • Set Impact Perimeter • Define Habitats & Subhabitats • Identify & Document Damage Pathways	Prior to Impact Cause Removal/Cessation (pending safety/field logistics concerns)	1° & 2° Impact Damage and Peripheral 1° Response Damage
The Impact Assessment (RETRIEVE)	• Document Specific Damage to Habitats, Subhabitats, Key Species • Collect Physical & Other Evidence • Identify Impacts to Users	Immediately After Impact is Removed/ Ceases (pending safety/field logistics concerns)	1° & 2° Impact Damage and Peripheral 1° & 2° Response Damage 1° Removal/Cessation Damage
The Rapid Ecological Assessment (REA) (REVIEW)	• Document Biomass, Biodiversity Impacts Relative to Control Sites • Identify Ecological Functions	Post-Removal or Cessation (pending safety/field logistics concerns)	1° & 2° Impact Damage and Peripheral 1° & 2° Response Damage 1° & 2° Removal/ Cessation Damage

Note that as an investigation proceeds, additional forms of impact need to be incorporated into the data gathering (see the damage timeline). Also note that during the REA phase, fieldwork occurs not only on the impact site, but also on appropriate reference sites in order to quantify probable loss and establish estimates of recovery. The REA phase is critical to an investigation for mitigation and restoration decision-making.

For any marine ecosystem injury, there are six (6) basic questions that form the core of the field investigation:

1. **What is the injury?** In other words, what caused the impacts observed?

2. **Where will it go?** What is the area of impact? Where are the primary and secondary impacts moving? Are there any public safety concerns?

3. **Who will it effect?** What are the natural resources at risk? What user groups will be displaced by this? Are there any public safety concerns?

4. **How will it effect?** What are the expected negative actions or negative impacts. Are there any public safety concerns?

5. **What can be done?** What are the emergency restoration, mitigation, and restoration recommendations.

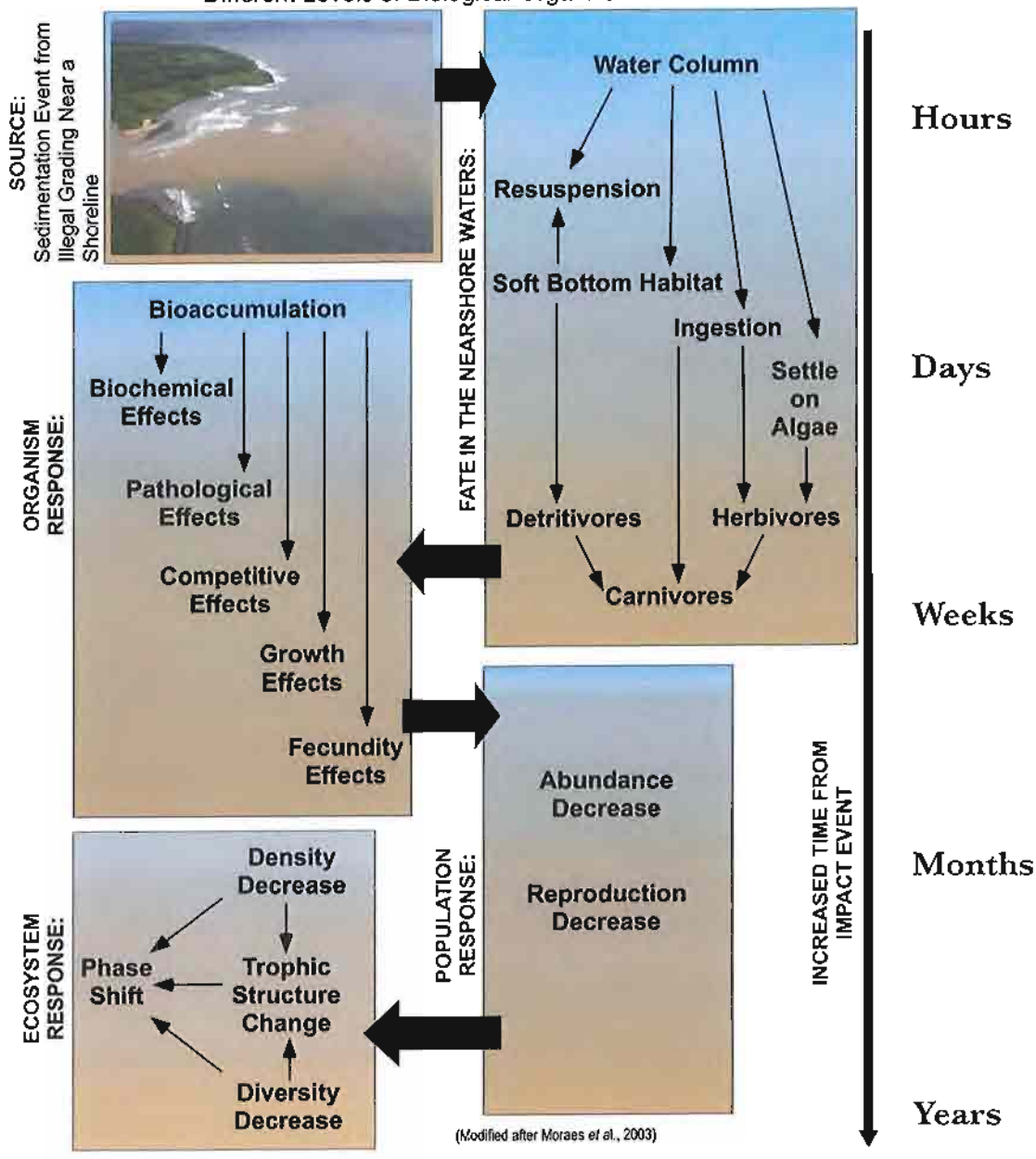
6. **Identify the endpoints?** What will need to be accomplished in order to end the injury response.

Dave Gulko

These are the questions (or the answers) that are always at the forefront during each phase of the field investigation and are always being re-evaluated by the field team as they approach each phase. They are also the key questions that should form the basis of the incident command center where the non-field Natural Resource Trustee (NRT) personnel manage the various aspects of the injury response (Public Safety, Security, Reconnaissance, Spill/Pollution Response, Salvage, Investigation, Clean-Up, Enforcement - note that not all of these components might be present in any single response effort).

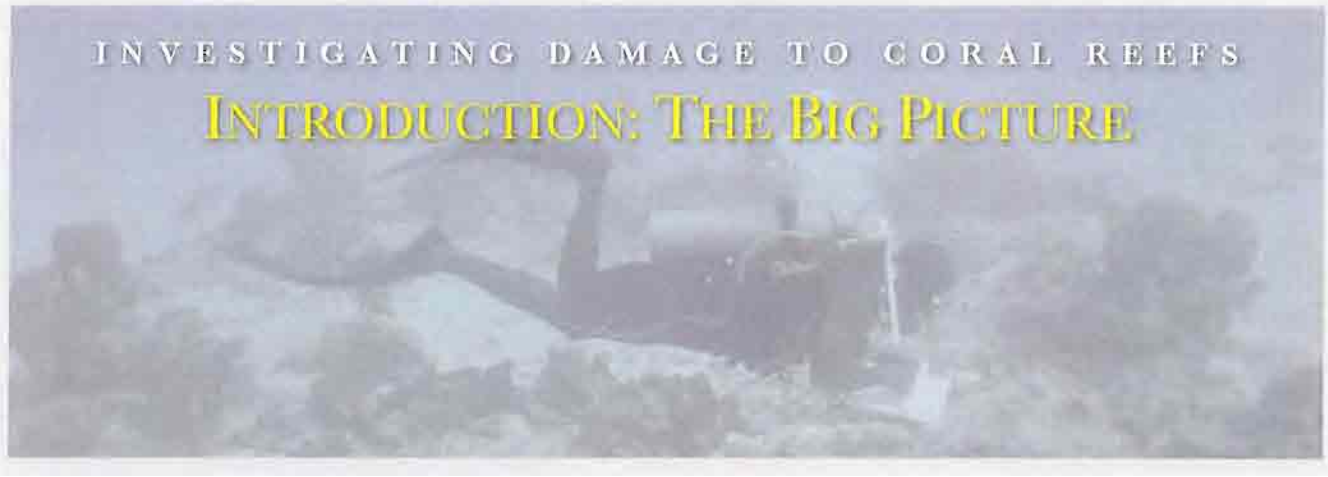
What Specific Aspects To Be Investigated May Change Ecologically With Time From The Start of An Event:

Conceptual Model Illustrating the Pathway from Source to the Receptor and the Hypothetical Cause-Effect Relationship on the Assessment Endpoint at Different Levels of Biological Organization

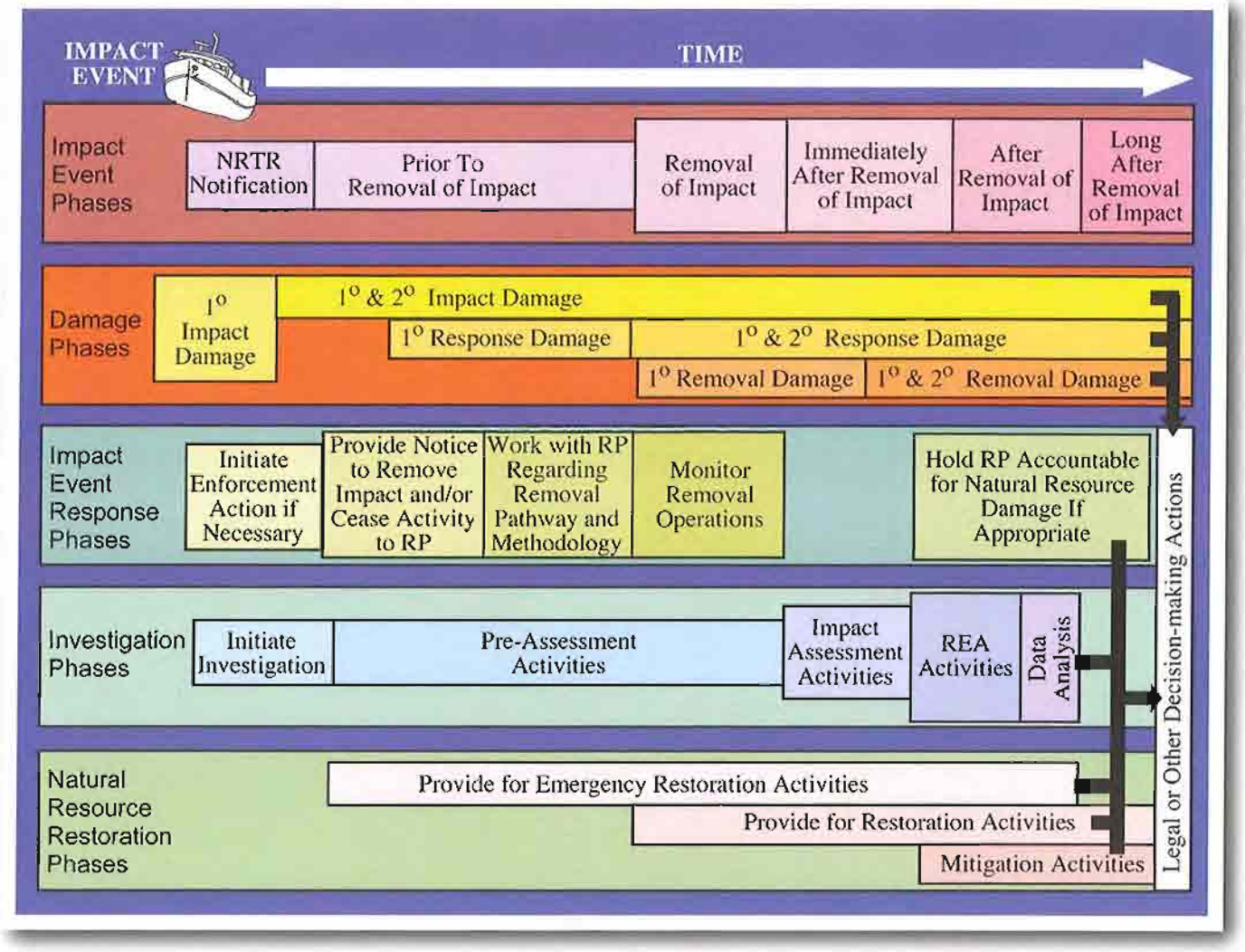


(Modified after Moraes *et al.*, 2003)

As an impact event proceeds over time, the ecological responses that can be readily assessed shift as the impact spreads over space and time. The result is that an investigation has to be able to shift focus in its study of effect in order to best capture the range of impacts occurring within an area and to be able to mitigate existing and probable future impacts.



The following reflects a broad, generalized and comparative overview of the overlapping timeline phases and activities involved in a marine impact investigation and how they can lead to enforcement or other decision-making actions. We will repetitively refer to this diagram throughout the various toolkit modules to provide guidance, anchoring and reference to various stages of the investigative process.



Note that different phases may occur independently of each other, but that certain response activities are constrained by various impact event phases. Also note that different phases may be handled by different agencies, or different individuals within a single agency, but will be most robust when broad coordination across phases occurs with a multi-agency approach; with each phase led by that agency with the strongest legal or resource responsibility relative to that phase.

The end result is that each activity within a response phase needs to be coordinated relative to both the follow-on activities within that phase, and the parallel activities within other phases. Furthermore, rarely does one know at the beginning of an investigation whether the end result will be in the form of prosecution, litigation, mediation, restoration or mitigation. That is why, given the ephemeral nature of underwater investigations, we conduct coral reef CSI as if every investigation is going to trial.

Key Factors to Consider for Any Injury Event

- Type of Impact
- Timing of Incident (Seasonality)
- Quantity of Impact
- Movement & Weathering of Injury Material
- Location of Injury Event
- Effectiveness of the Response Actions
- Biological Sensitivity of Marine Areas
- Shoreline Type

CSI: What Does It Mean for Coral Reefs?

Coral reef CSI is similar to CSI conducted for terrestrial crime scenes (especially wildlife crimes) but differs in some key ways that require special considerations.

Basic CSI Tasks:

- Evaluating the scene & evidence
- Documenting the scene & evidence
- Preserving & Collecting evidence

Ken Goddard

The Purpose of Police CSI:

1. Determine if a crime has been committed.
2. ID the victim(s).
3. ID the suspect(s).
4. Collect evidence related to the crime.
5. Re-enact the events of the crime.
6. Link suspect, victim & crime scene.

The Purpose of Coral Reef CSI:

1. Determine if a coral reef crime or injury has occurred.
2. ID the injured resource(s).
3. ID the potential Responsible Party (RP).
4. Collect evidence related to the crime/ injury.
5. Re-enact the events of the crime/injury.
6. Link RP, resource damage & injury scene.

TERRESTRIAL (POLICE) VS CORAL REEF CSI

	POLICE CSI	CORAL REEF CSI	RESULTING ISSUES FOR CORAL REEF INVESTIGATIONS
ASSAULT ON THE VICTIM	A human is assaulted and/or killed by another human. The event is usually **intentional** and usually **focused** on a specific individual. Most common weapons: firearms, knives, vehicles, clubs, rocks, workshop tools and kitchen implements.	A coral reef is 'assaulted' by ships, spilled oil, spilled fuel, chemical dumping, fertilizer run-offs, oil run-offs (streets & sewers), sewage spills/ run-offs and heavy-metal run-offs. The assault is usually **unintentional** and **not focused** on a specific reef.	- Wider range of **types** of 'suspects'. - The natural background may pose **as great a risk** to investigators as the injured area. - May have multiple agencies with **jurisdiction** over the investigation.
FIRST RESPONDING OFFICER	Typically a **uniformed** patrol officer.	Typically a marine investigator or a marine biologist.	- May have difficulty establishing **authority** and public safety control - involve uniformed enforcement officers if possible.
FIRST RESPONDING INVESTIGATOR	Typically a detective. Depending upon the seriousness of the crime (homicide or assault), **additional investigators** and/or a CSI team will respond to the scene.	Typically a marine investigator who will investigate the entire scene **without assistance.**	- Field investigator needs to **do more with less** resources in **far less time** - rare to get a second chance at investigating the crime scene.
CSI EQUIPMENT AT THE SCENE	Investigators carry basic CSI gear in their vehicles. CSI officers typically respond to a scene in a **van loaded with specialized equipment**.	Marine investigators must bring all of their CSI equipment onto a boat …. and with them underwater. Scuba gear represents the majority of the marine investigator's equipment.	- Field investigator needs to **do more with less** gear in **far less time** - rare to get a second chance at investigating the crime scene.

	Police CSI	Coral Reef CSI	Resulting Issues for Coral Reef Investigations
Crime Scene Perimeter Purpose of scene perimeter: prevent damage to (or alteration of) the scene and evidence by on-lookers and ensure public safety.	The first responding officer establishes initial scene perimeter with **'barrier' tape.** Scene perimeter will be expanded or reduced as investigation continues.	Given the constant flow of salt water, three-dimensional access, and the delay between the 'assault' and the investigation, it is probably not possible --- or worth the effort --- to set an effective physical 'barrier' around a coral reef scene.	- Need to **prevent damage or alteration to injury scene** and **ensure public safety - without** physical barriers - requires active enforcement of perimeter and active education of user groups.
Crime Scene Documentation	The Investigator or CSI team will take **numerous** over-all, medium range and close-up photos; set evidence location tags; prepare an evidence list; and make a rough crime scene sketch at the scene. May take hours or days to document scene. **All** evidence items (collected or not) will be photographed and noted on the evidence sketch.	The marine investigator will document the damaged reef within a **very limited amount of time** (and therefore with a limited number of underwater photographs) **- usually under an hour.** Sketches are roughly made underwater and fleshed in on the boat or at the investigator's office.	- Limited time underwater requires investigators to **prioritize** objects and scenes photographed underwater, while ensuring that a standard range of photos are taken.
Notes & Sketches	Scene notes and sketches are comprehensive (lots of details!) and **always made in ink.** All crime scene notes and sketches are made at the scene.	It is not possible to make more than a few notes during an underwater investigation of a coral reef … and the notes usually cannot be made in ink underwater. Notes and sketches are frequently fleshed-in back on the boat or later at the office.	- To maximize chain-of-custody with notes and sketches in pencil, **photograph all notes and sketches immediately as divers exit the water.** - Underwater notes from all team members should be cross-compared and a overall brief created by the CROC.

	Police CSI	Coral Reef CSI	Resulting Issues for Coral Reef Investigations
Audio Recordings	A CSI officer typically makes an audio recording of all events and actions taken at the scene during the investigation process.	Audio recording during an underwater investigation requires expensive equipment rarely available to marine investigators.	- Emphasis needs to be on photos and notes taken underwater at the scene. - If underwater audio communication equipment is available, should record the communications.
Crime Scene Photographs	The scene is first photographed from outside the scene perimeter looking inward (over-all shots). All discovered evidence items are ID'd with an evidence location tag or marker, and then photographed at medium (including the surrounding area) and close-up ranges.	The coral reef and any discovered evidence items are typically photographed with a few over-all and medium range shots. Evidence tags must be carefully used in a underwater medium - difficult to attach tags to injured wildlife underwater.	- Limited time underwater requires investigators to **prioritize** objects and scenes photographed underwater, while ensuring that a standard range of photos are taken.
The Victim's Body	The body of the victim is not moved or searched until the coroner (or coroner's investigator) arrives. The coroner searches the victim (body and clothing) for evidence; places the victim into a body bag; and then **transports the victim to a Morgue where an autopsy will be conducted** to determine cause of death.	The victim (the coral reef) usually cannot be moved from the scene. Samples from damaged susbtrate or organisms can be sampled underwater but often require careful transport out of the area and to a analytical lab - many marine labs aren't well set-up for ensuring proper chain-of-custody.	- The Coral Reef Investigator needs to cover **all** duties usually handled by various people at a land investigation. - Most of the injury investigation (including detailed examination) must occur **underwater** at the injury site. - The investigators may have to train local marine labs in chain-of-custody standards for the region.

	Police CSI	Coral Reef CSI	Resulting Issues for Coral Reef Investigations
Time at the Scene	Crime scene investigators will typically spend **3 to 12 hours at a crime scene** … searching, documenting and collecting evidence.	Depending on the depth of the reef, a marine investigator can only spend **2 to 3 hours** (three or four 45-minute dives) at the scene before forced to stop diving for the day due to nitrogen build-up.	- Limited time underwater requires investigators to **prioritize** searching, documenting and collecting evidence. - The nature of marine habitats changes so frequently that there is a very limited time window to conduct an investigation before the injury scene may become compromised.
Autopsy of the Victim	A medical examiner will **autopsy** the body to determine the cause of death. All suspicious markings and evidence items will be photographed. The autopsy usually **takes place after the crime scene investigation has been completed.**	A marine investigator or biologist will typically conduct the '**evaluation**' of the coral reef **on-site** to determine if it is 'dead' or 'dying' or 'seriously impacted.' All obvious 'outer' signs of damage should be photographed. 'Autopsy' of the reef will probably take place **before** the scene investigation.	- The in-water investigators need to be trained in injury investigation, resource mitigation and coral reef ecology. - Coral reef assessment and monitoring of high value marine habitats should occur prior to injury events. .
Toxicology Analysis	Blood, urine and liver samples are routinely collected from the victim for toxicology analysis.	Difficult to collect 'tissue' samples from a coral reef that might accumulate toxins. Need to associate components of reef (specific fish, invertebrates and seaweed) with specific injury.	- Requires a team member with training in coral reef ecotoxicology or the team having access to a marine ecotoxicologist.

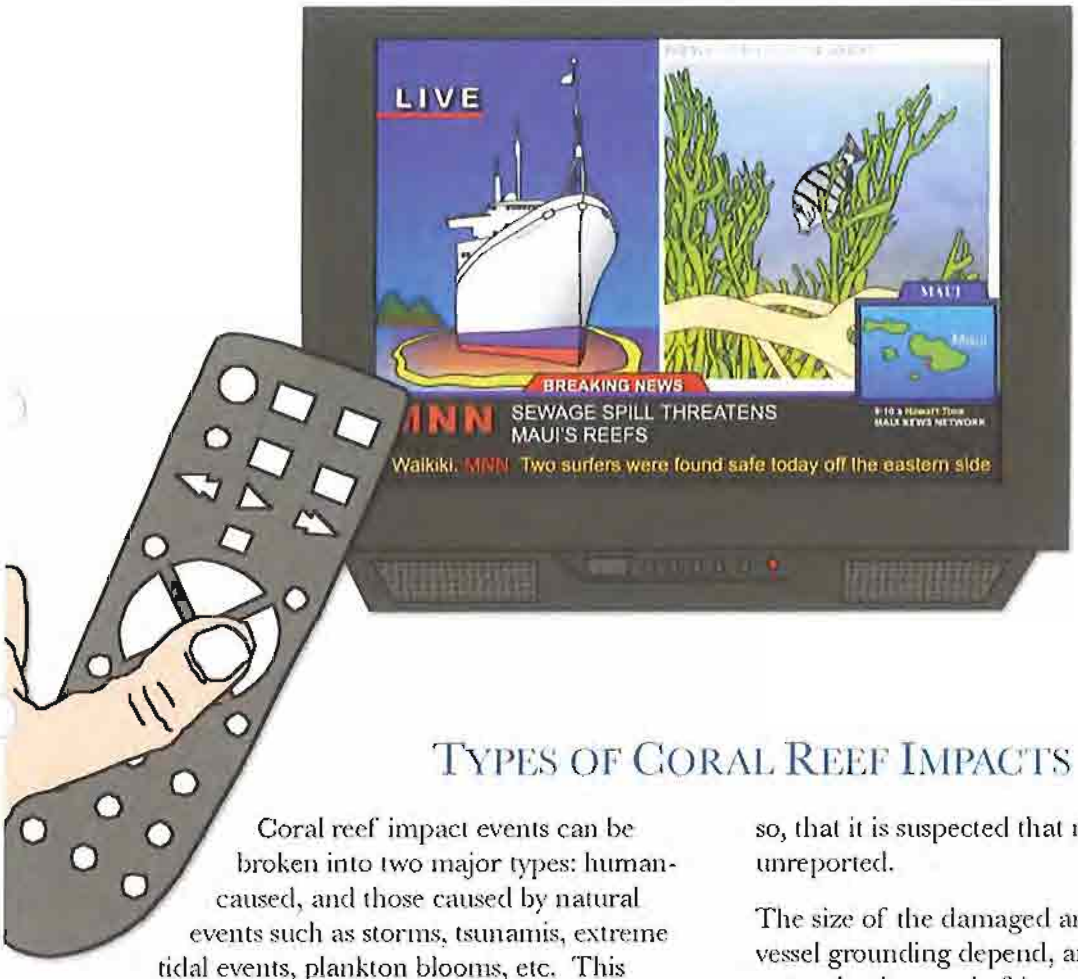
	Police CSI	Coral Reef CSI	Resulting Issues for Coral Reef Investigations
'Impact' Evidence	The medical examiner will collect bullets and other 'impact' evidence found in or on the body.	The marine investigator will search for 'impact' evidence such as metal fragments (anchor), paint chips and silt samples scattered around the reef.	- Limited time underwater requires investigators to conduct an organized search for evidence surrounding the injury site.
Cause of Death	The medical examiner will utilize his/her observations in addition to toxicological reports to determine the **precise** cause of death of the victim.	The definition of 'death' of a coral reef is **vague at best** ... and includes the health of organisms normally living within the coral reef structure.	- The in-water investigators need to be trained in injury investigation, resource mitigation and coral reef ecology.
'Body' Wounds	The means of killing a human being are **well understood**, and usually detected and **confirmed easily**. It is **usually easy** to separate recent wounds on a human body from those occurring much earlier.	A coral reef may **accumulate** 'wounds' from 'impacting events' over several months, years or even decades. It **may not be possible** to distinguish impacts occurring recently from those occurring over a period of months or years.	- The in-water investigators need to be trained in injury investigation, resource mitigation and coral reef ecology. - Coral reef assessment and monitoring of high value marine habitats should occur prior to injury events.

	Police CSI	Coral Reef CSI	Resulting Issues for Coral Reef Investigations
Evidence Preservation	Wet evidence is dried, then placed in paper evidence bags. CSI officers have well-established means of preserving, packaging and sealing items of evidence.	All coral reef evidence is exposed to corrosive salt water that negatively impacts efforts to preserve, package and seal the evidence. The efforts necessary to properly collect a single item of evidence at a coral reef will limit the number of items collected by a single investigator.	- Special care has to be used when handling evidence underwater and after it's been brought to the surface. - Coral reef assessment and monitoring of high value marine habitats should occur prior to injury events. .
Evidence Storage	CSI officers have well-established means of storing and otherwise preserving the 'chain-of-custody' of their evidence.	**Few** marine investigators have secure evidence storage systems.	- Need to have **secure** evidence storage facilities that can handle evidence that is either biological in nature or that has been in seawater.
Forensic Examination of Evidence	CSI officers have local, county, state and federal **crime labs staffed with professionally-trained forensic scientists** to properly examine and compare their collected evidence items.	Marine investigators do not have crime labs or professionally-trained forensic scientists dedicated to the examination and comparison of coral reef evidence.	- Need to pool regional resources, and may need to take advantage of international wildlife crime lab resources for large or extremely important cases.
Conflict of Interest	Forensic examiners should **not** examine evidence they collect at a scene (conflict of interest).	Evidence collected at the coral reef may be examined by the collecting Marine Investigator or other coral reef biologists.	- The in-water investigators need to be trained in injury investigation, evidence analysis and handling.

	Police CSI	Coral Reef CSI	Resulting Issues for Coral Reef Investigations
Cost of Analysis	Investigating Agencies are **rarely charged** for the forensic analysis of their evidence.	Most Marine Agencies will have to **pay outside labs** for the forensic analysis of their evidence.	- Need to pre-arrange agreements with appropriate wildlife crime labs to assist relative to unique marine injury parameters (which they normally would have little, or no, experience with).
Purpose of Investigation	Enforcement of Laws Prosecution of Suspects	Basis for: Emergency Restoration/ Response Negotiation, Arbitration, Litigation Enforcement of Laws Prosecution of Suspects Mitigation*, Restoration * to cause to become less harsh or hostile.	- Requires a field team representing all NRTs who can look at various aspects using the data from a limited number of assessment dives.

BASIC MARINE INVESTIGATIVE TOOL

TYPES OF IMPACT EVENTS



TYPES OF CORAL REEF IMPACTS

Coral reef impact events can be broken into two major types: human-caused, and those caused by natural events such as storms, tsunamis, extreme tidal events, plankton blooms, etc. This section will focus only on those major impact events caused by human actions.

Vessel Groundings

Coral reef areas are widely navigated by both small and big recreational and commercial vessels. Even though navigation technology has improved greatly, vessel groundings on shallow areas remain one of the most common causes of coral reef damage; so much so, that it is suspected that most groundings go unreported.

The size of the damaged area and the effects of a vessel grounding depend, among other things, on: water depth, speed of impact, size and weight of the vessel, time taken to rescue the vessel, the response effort itself (for many ships, more physical damage is done by the response effort then by the initial grounding), weather conditions and the biological integrity and structure of the affected habitats.

Once a vessel makes contact with a reef, the following actions influence the amount of damage caused to the reef. Currents and bad weather may move the vessel without freeing it, causing more harm. Response vessels (or their towlines or anchors) may have to make contact with undamaged reef areas to reach the stranded vessel. If the cables used in the response effort are not handled with care (or floated), these may add more damage. Further loss may occur if the hull breaks and spills of cargo and other substances happen; these may include chemicals, ballast water,

fuels, etc., that can be toxic for the coral reef organisms that have not been directly damaged by the physical grounding by making them more susceptible to disease and less prone to recovery.

The most common physical injuries seen with vessel groundings are: abrasion and tissue damage, dislodging of intact colonies or reef structure, fragmentation and overturning of colonies, creation of rubble and sediment, direct loss and burial of live reef organisms, fracturing of underlying reef structure, flattening of diverse habitats, and the presence of toxic antifouling paint. The action of the propeller, if engaged, can create a blow hole in the relatively soft limestone reef structure, scattering rubble and sediment to other nearby areas. (Precht, 2006). Large ship groundings cause fundamental changes in reef topography and biological communities which can often take decades to recover.

Anchor Damage

NOAA

A regular practice to hold a ship in place above a particular area on a reef has been to drop an anchor. The steel or iron anchor is attached to the vessel by a chain or line, that holds the ship in place by hooking it to the bottom substrate. Unfortunately this often crushes and destroys the coral and organisms living within it.

Often an anchor will not hold on the first attempt but would tear out pieces of coral, sponges, or any other substrate that it may encounter, often dragging along the bottom and damaging sections of reef far greater then the linear length of the chain and anchor in contact with the bottom. Later, when the ship is ready to leave, the anchor is pulled and wiggled, tearing out even more reef. If the line that holds an anchor is too heavy, the elasticity that absorbs the movement shock will not be enough and the anchor may be displaced and dragged.

Because coral reef areas are visited by large numbers of ships, many MPAs have outlawed the use of anchors to all types of vessels, installing in exchange public mooring buoys, which are fixed floating devices with an attached pick up line where vessels can be tied to, and therefore avoiding the use of, and the damage caused by, anchors. In Australia for example, the Great Barrier Reef Marine Park Authority (GBRMPA) have standardized throughout the marine park five classes of moorings to cater for different vessel types and lengths.

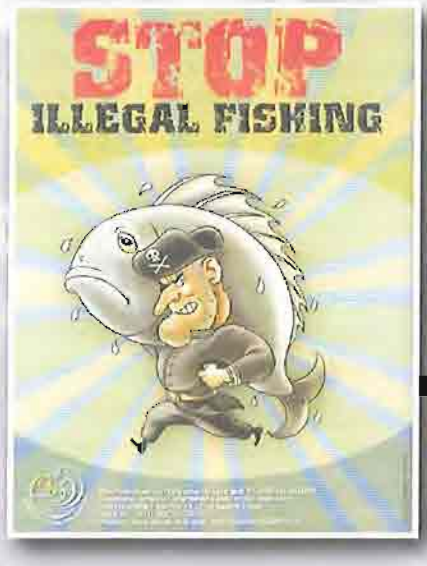
AVRAM (http://www.reefbase.org)

If anchors are dropped, on purpose or by accident, the size and weight of the anchor determines the amount of damage that it can cause. Big vessels can inadvertently drop and drag an anchor causing ample damage along its way. Anchors dropped and dragged through a coral reef leave very characteristic scars; these are linear, with constant width and if the anchor bounced during the event, the wound may be discontinuous. Another feature, which often is the most useful indicator of anchor damage, is the presence of overturned colonies (Dinsdale and Harriot, 2004). Unfortunately, anchor damage may be very difficult to recover from; for example, in the Virgin Islands where after ten years post-event live coral cover in the still-visible scar remained well below the cover found in the adjacent, undamaged reef (Rogers and Garrison, 2001).

Georg Heiss (http://www.reefbase.org)

Illegal Fishing

Fishing has the capacity to damage fragile marine ecosystems (such as coral reefs, seagrasses and mangroves) and vulnerable species such as coral colonies, turtles and seabirds. Regulating legitimate fisheries is aimed at mitigating such impacts, but



Departemen Kelautan dan Perikanan (www.dkp.go.id)

illegal, unregulated and unreported fishers rarely comply with regulations. This situation is likely to reduce biodiversity and productivity, thereby altering the ecosystem balance. This may lead to reduced food security in communities heavily dependent on fish as a source of animal protein (http://www.illegal-fishing.info).

Joëlle Lai N. Sivasothi (http://www.reefbase.org)

Legal and illegal fishing methods cannot by themselves destroy stable ecosystems, however through the effects of synergy, they have led to the breakdown of large coastal areas which used to be excellent fishing grounds. The rising demand for live coral fish in rich, nearby countries which pay increasingly high prices, combined with extreme poverty, low wages, and no alternative sources of income, push fishermen to illegal practices.

Among illegal fishing practices, the capture of immature and juvenile specimens can have dire consequences because it does not allow individuals to reach sexual maturity and reproduce to replenish the population. Many fisheries are well studied and fishing quotas are calculated to maintain a balance between what is produced and what is taken, therefore fishing above permitted quotas or fishing during closed seasons (which many times is also the reproductive seasons) also contributes to the decrease of fish stocks.

Some species are especially vulnerable due to their biological or life history characteristics, and upsetting the natural balance of these populations is easy when they are intensively captured. For example, sea turtles need many years to reach sexual maturity and even then most hatchlings die in their first year of life naturally. Fishing pressure has dramatically decreased their stocks, and today many countries have given them some protection status. Turtle egg poaching is an activity that is difficult to control since extensive beach areas are used by females to lay their eggs and surveillance capacity is usually limited.

James Oliver (http://www.reefbase.org)

Destructive Fishing

There are a number of fishing practices that have been banned in most coral reef areas of the world because they destroy the physical structure of the coral reef or kill non-target organisms in large numbers.

Dynamite or Blast Fishing.

Blast fishing is the use of dynamite, homemade bombs, and other explosives to kill or stun fish and other organisms that can later be easily gathered. Fishermen who use this technique often only scoop up 40 percent or less of the dead fish from the surface, leaving the rest to rot on the ocean floor. This system is extremely destructive because the shock wave that results may break and pulverize corals and therefore the habitat itself, leaving deserted areas that may take decades to recover. This technique is still prevalent in Indonesia, the Philippines, and Vietnam, and also is known to occur in East Africa, Sri Lanka and Thailand.

Jeffrey Jeffords (www.reefbase.org)

Blast fishing dates back to before World War I and has remained widespread because it is a cheap and easy way to get a fish catch, all that is needed is a fuse, a beer bottle, and a mixture of diesel and fertilizer. However, these types of homemade bombs are very unstable and many accidents have killed and injured fishermen and innocent bystanders.

Cyanide Fishing.

Because dynamite fishing has been banned in many coral reef areas, some unscrupulous fishermen looked for other ways to continue catching fish without much trouble and noise, one unfortunate answer has been the use of sodium cyanide. This chemical compound dissolves in water liberating cyanide ions which are toxic to most organisms.

Jeffrey Jeffords (www.reefbase.org)

Cyanide combines with respiratory molecules like hemoglobin and others, blocking the flow of oxygen to cells, stunning fish, and causing death after a short time. Coral polyps, young fish and eggs are most vulnerable. Even brief exposures to cyanide causes mortality or long-term damage to corals and anemones at much lower levels than that used by fish collectors, so the effects of this practice may be wider than expected (Cervino *et al.*, 2003). Adult fish can take higher doses and may be able to rapidly excrete the cyanide molecules; which is one reason this method is used to gather fish for the aquarium trade.

Fishermen crush cyanide tablets and then dissolve it in squirt bottles with sea water; they then dive, and when they reach the coral reef, spray the cyanide inside the caves and crevices of the reef. This method kills or stuns almost all marine organisms. Some stunned fish remain in their caves and fishermen proceed to smash the coral or live rock to get at them.

Aquarium fish are caught without causing them much physical damage and may also survive, but studies have shown that the combination of cyanide use and stress of post-capture handling results in mortality of up to 75% of the organisms within less than 48 hours of capture. With such high mortality numbers, a greater number of fish must be caught in order to supplement post-catch death (http://www.illegal-fishing.info).

Apprehending fishermen that have used cyanide is not an easy task, however some progress has been achieved in the detection of cyanide in coral reef fish using chemical tests and biosensors (Mak *et al.*, 2005).

Chlorine Fishing

This is a variation of cyanide fishing in which pool chlorine or household bleach is put in a plastic bag or squirt bottle, and then sprayed in a hole in the reef so the chlorine drives fish and lobsters out of holes and into gillnets. This practice also has toxic effects on corals and other marine creatures, and is been banned in many countries.

Destructive Nets & Traps

Bottom gill-nets and surface-deployed traps often cause extensive habitat damage as they lay and move about the bottom. This is in addition to the non-selective nature of the gear itself which often traps and kills a wide variety of organisms not targeted by the fisher, including sea turtles, dolphins and non-food reef fish.

Elizabeth Wood (http://www.reefbase.org)

Sedimentation Events

Some on-shore activities like urbanization and deforestation combined with intensive rains, can bring to the ocean huge amounts of soil particles and debris; eventually these settle on the bottom burying all organisms that cannot move away like corals. The effects of these sediments will depend on their amount and composition, but also on the current conditions in the area, which can take them away or let them settle to blanket the reef.

USGS

Corals may expend a huge amount of energy trying to get rid of the soil particles, which can debilitate their immune system and in the end suffocate them. Among the illnesses that can be favored by the presence of soil particles are coralline lethal orange disease and black band disease, which is caused by a cyanobacterium pathogen.

Sediment effects could be indirect through the blocking of sunlight penetration, which reduces photosynthesis and therefore stresses the symbiotic algae in coral tissues.


Yusri Yusuf (http://www.reefbase.org)

Suspended sediments also have unfavorable effects on the plankton food sources for the corals which can slow down their growth. Recruitment may also be affected since sediments prevent successful settlement of the coral larvae.

Coral sensitivity to sediment stress varies with species, therefore in areas with high inputs of terrigenous sediments changes in coral biodiversity may occur, resulting in the loss of sediment-sensitive species (example: *Montastraea annularis*), but not markedly affecting sediment-tolerant species (Torres and Morelock, 2002).

Sewage Events

During intensive rain events, excess wastewaters can enter the marine environment polluting the water and damaging corals. Wastewaters can contain a variety of substances, particles, debris and other materials, that depending on their nature and amount can make corals more susceptible to illness or kill them by burying them or intoxicating them. Excess freshwater can also cause osmotic stress to corals which adds to the effects of the other substances in the sewage.

Nutrient enrichment may favor algal blooms not only on the water column, decreasing light penetration and therefore zooxanthellae photosynthesis, but also on top of the coral already debilitated by the presence of excess sediment or sewage particles.

Chemical Spills

The effects of chemical spills on coral reef organisms depend on the nature of the substance spilled, the amount, the currents and meteorological conditions, but also depend on the time of the year because coral reproduction and early life stages are particularly sensitive. Corals may be more or less sensitive than crustaceans or fish to a particular chemical, so generalizations are difficult; that said, most chemical effects are sub-lethal, but since the ultimate effect may be to prevent successful settlement or reproduction, the end result is the same as if the coral had died.


James Oliver (http://www.reefbase.org)

Oil spills are the most studied type of chemical spills, and these can kill corals that they come in contact with. The degree of damage depends on the coral species, life stage, and exposure. Branching corals, for example, are more sensitive to oil impacts than are massive or plate-like corals.

Corals will be affected differently depending on how they are exposed to oil. Direct oil contact is possible when surface oil is deposited on intertidal corals (corals that are exposed at low tide). Oil mixed in the water column can also expose corals to harmful oil constituents. This is most likely to happen if seas are rough and the oil is a lighter, more soluble product. Subsurface oiling can smother coral if heavy oils thin out from exposure to sun and wind or if they mix with sediment and become heavy enough to sink. Efforts to break-up oil with chemical dispersants can also be lethal to various life stages of corals. Negative dispersant effects can also be increased because these substances make the oil components dissolve in the water and in this situation substances are easily taken up by organisms.

Pollution, such as that associated with oil spills, can also make corals more susceptible to coral bleaching. Corals that withstand bleaching still suffer reproductive impairment, slowed growth, and a decreased ability to repair themselves (NOAA, 2007).

Fish Kills

James Oliver (http://www.reefbase.org)

Infrequently, dead fish or other marine animals wash ashore in groups or large amounts. Such events can be the results of injury events on a reef (usually the release of some chemical or use of non-selective fishing gear) or the result of some natural or weather phenomena. Rarely is the event associated with the scene where the organisms are found; and as such, this type of event often has a shorter investigative time window than many others.

Invasive Species

Jen Smith

The newest form of major impact event is the accidental or purposeful introduction of aquatic invasive species (AIS) to the coral reef environment. In most cases, this is usually either a plant, benthic invertebrate or some sort of microorganism. The effects can be devastating over a relatively short time period; and once introduced, AIS is usually extremely difficult to remove or even control.

Other Impacts

A wide range of other impacts can be caused by humans in the coral reef environment; to date, these aren't as wide-spread yet. Areas where there has been past military activities or bases may often have waste munitions lying atop or incorporated into the reef structures. Heavily used tourist reefs may suffer from direct physical impact caused by uneducated or non-compliant visitors. In some cases, bad habits seen by people on land regarding waste disposal, graffiti, and harassing animals is starting to be seen on the reefs.

John McManus (http://www.reefbase.org)

AV KAM (http://www.reefbase.org)

Elizabeth Wood (http://www.reefbase.org)

The Three Basic Types of Coral Reef CSI Investigations

There are three basic types of Coral Reef CSI investigation[1]:

1. **Type I Investigation.** Cause of impact is known, but the type and scale of impact is unknown. This is the most frequently encountered type of investigation. Examples include vessel groundings, sewage spill, illegal fishing, sediment spill, illegal trade, oil spill, etc.

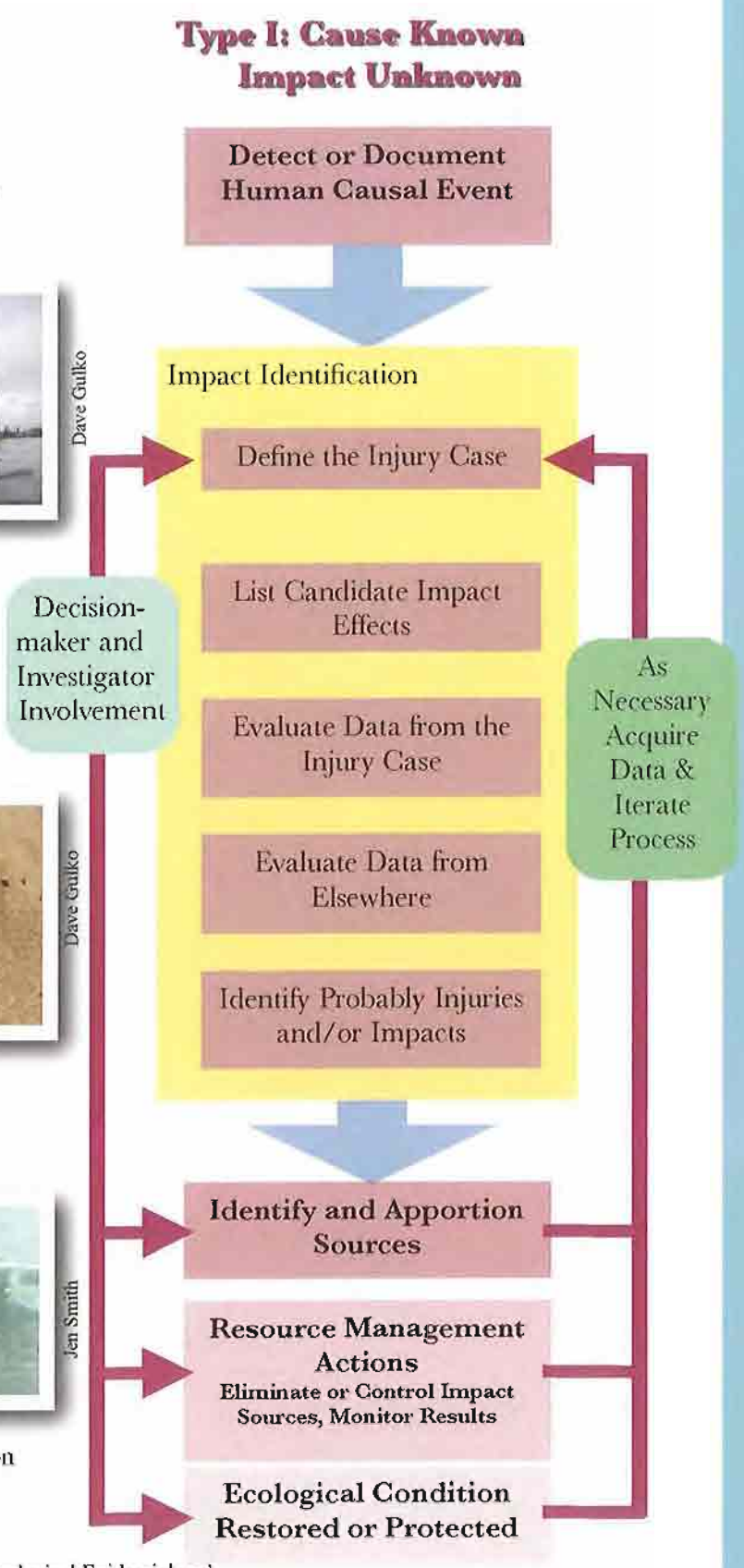
Dave Gulko

2. **Type II Investigation.** Cause of impact is unknown, but the type and scale of impact is readily known. Example: A fish kill where dead fish wash ashore, A large, over-turned coral colony is found on a reef.

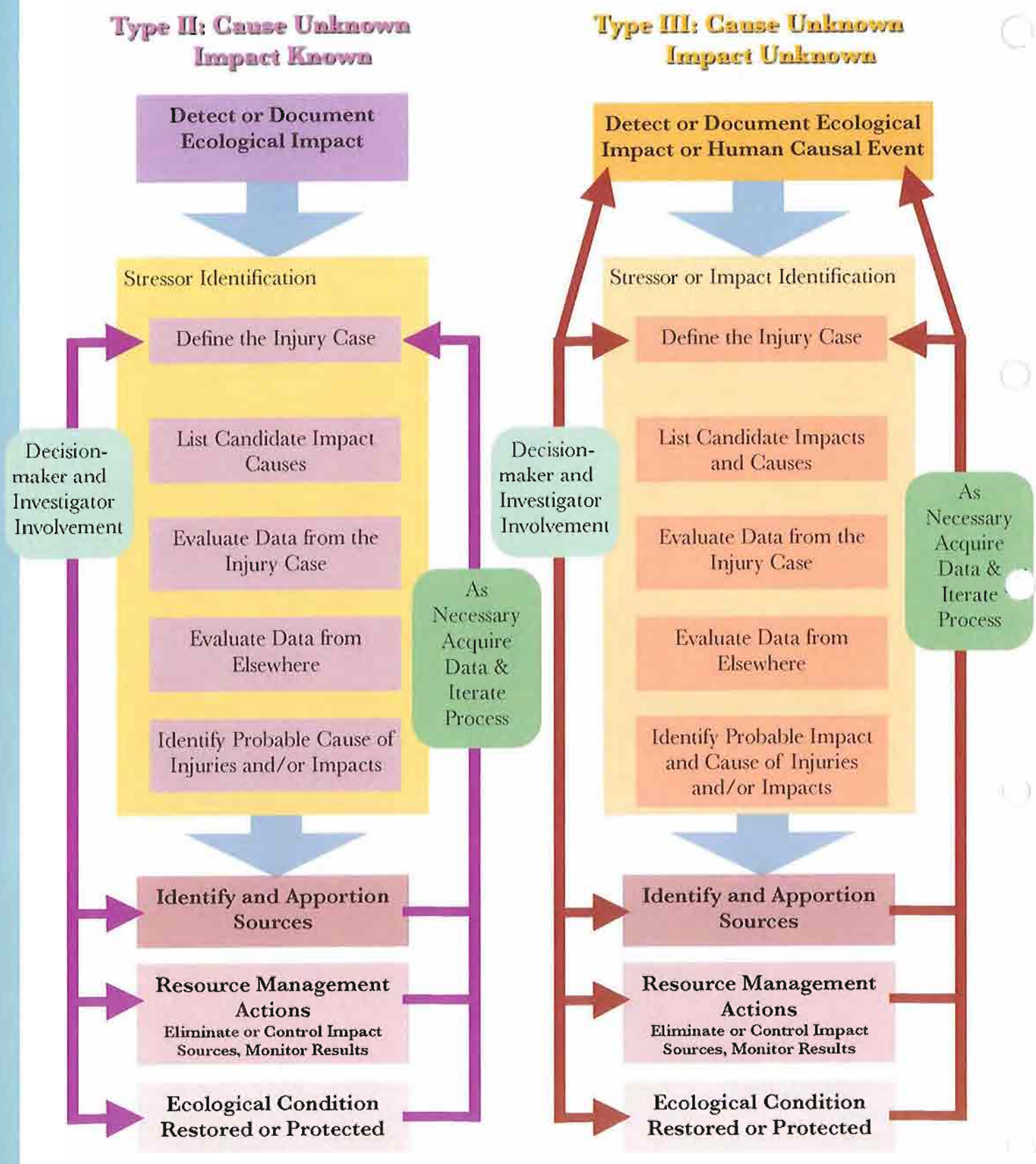
Dave Gulko

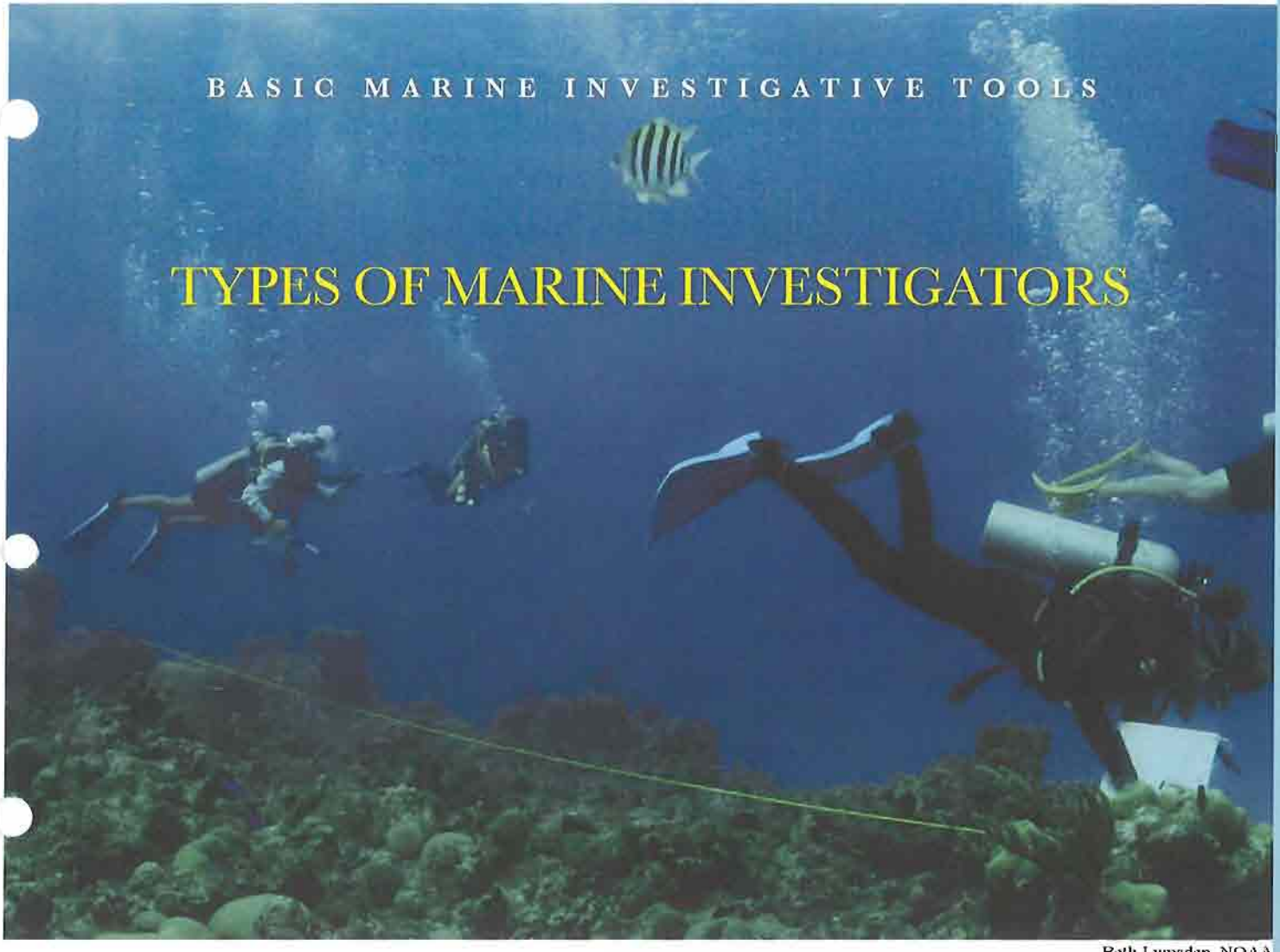
3. **Type III Investigation.** The cause of the impact is unknown and the type **and** scale of the impact is unknown. This is the least common form of Coral Reef CSI investigation. Example: A nutrient bloom on a reef.

Jen Smith



[1] Modeled after G Suter, USEPA (2006). 'Causal Analysis for Ecological Epidemiology'.


Type II: Cause Unknown Impact Known
Detect or Document Ecological Impact
Stressor Identification
Define the Injury Case
List Candidate Impact Causes
Evaluate Data from the Injury Case
Evaluate Data from Elsewhere
Identify Probable Cause of Injuries and/or Impacts
Decision-maker and Investigator Involvement
As Necessary Acquire Data & Iterate Process
Identify and Apportion Sources
Resource Management Actions
Eliminate or Control Impact Sources, Monitor Results
Ecological Condition Restored or Protected
Type III: Cause Unknown Impact Unknown
Detect or Document Ecological Impact or Human Causal Event
Stressor or Impact Identification
Define the Injury Case
List Candidate Impacts and Causes
Evaluate Data from the Injury Case
Evaluate Data from Elsewhere
Identify Probable Impact and Cause of Injuries and/or Impacts
Decision-maker and Investigator Involvement
As Necessary Acquire Data & Iterate Process
Identify and Apportion Sources
Resource Management Actions
Eliminate or Control Impact Sources, Monitor Results
Ecological Condition Restored or Protected



Beth Lumsden, NOAA

INTRODUCTION

During an injury incident, Natural Resource Trustees (NRTs) are often activated in various orders to assist or comment on the event, organize the response, or interact with the Responsible Party (RP) and/or media. For many jurisdictions, wearing multiple titles is often the norm; frequently each member of the CSI team will play multiple and different roles. Each case will be different but the components of the team remain essentially the same. The overall CSI team will be split up into 3 sub-components:

- Incident Command Personnel
- Surface Support Personnel
- In-Water Team Personnel.

Beth Lumsden, NOAA

Types of Personnel

Incident Command Personnel

The Incident Command System (ICS) is a standardized response management system. It is an "all hazard – all risk" approach to managing natural resource damage response operations as well as other crisis events. It was originally designed by a group of local, state, and federal agencies with wild- land fire protection responsibilities, to improve the ability of fire forces to respond to any type of emergency. It is organizationally flexible and capable of expanding and contracting to accommodate responses or events of varying size or complexity, with all information passing through, and decisions emanating from the Incident Command Center, and from there, relayed to the Government and/or the media. There is one person (**The Incident Commander**) in charge, to whom all information must be given from various components of the ICS, including the injury assessment and field response teams. The Incident Command Center typically consists of an Incident Commander (usually a designated lead within a NRT agency), NRT personnel with natural resource emergency response authority, some Technical Officers, Enforcement personnel and a Public Relations Official (PIO). All participants should be trained in basic ICS (ICS 100 available on-line for training purposes).

Surface Support Personnel

The personnel on the boat who directly assist the in-water team. This team will typically consist of:

- **Boat Captain** - Responsible for the vessel, all on-board operations, transportation to and from the scene and the transfer of information to shore. Captain should have extensive experience in boat handling within the region.

  The CROC - The Coral Reef On-scene Coordinator (The CROC) often stays aboard the boat to coordinate all aspects of the investigation. The CROC is the single person in the field most in charge of the investigation from the NRT perspective and is responsible for ensuring the proper documentation and storage of all data, photos and evidence. Often the CROC will also serve as a surface divemaster to log all diving and in-water activities.

  Surface Technician(s) - Ensure that all equipment is functional and present. May serve as a surface snorkelor taking GPS, retrieving gear, etc. Assists with diver deployment and retrieval. Responsible for evidence collected, the placement in evidence bags, and documentation. Cleans gear and assists with decontamination.

- **Enforcement Officers** - Ensure that the scene is not disturbed and that onlookers stay outside of the event perimeter. Enforcement officers have legal power of arrest, search and seizure.

In-Water Personnel

These individuals carry out the pre-assessment, impact assessment, and REA dives, which include marking the event and impact perimeter, conducting REA's and the collection and storage of underwater evidence. Divers will each have allotted tasks and often have expertise in one or more areas while at the same time having background in injury investigation;

Divers will have extensive background in either resource management or scientific diving, and diving safety. All divers should be trained in coral reef CSI techniques focusing on chain-of-custody and evidence collection underwater.

Dive Leader - Amongst the dive team, the senior member or the member with the greatest experience in diving safety and risk management will be designated as the Dive Leader. The Dive Leader is responsible for the Dive Plan and coordinating with the boat captain, CROC and/or divemaster.

Safety Diver - In some situations, a dive team may need safety divers to accompany them to an injury site. Safety divers are divers whose only role is to watch over the other team members underwater relative to hazards present in the field.

The remaining positions may vary depending upon the region and expertise available. In some cases, divers will fill multiple roles. Often dive team members should specialize but be able to also cover another diver's field if that diver is incapacitated or unavailable.

Coral Diver - Coral expert or team member tasked with coral identification and evaluation.

Algal Diver - Algal ecologist or team member tasked with algal identification and evaluation.

Invertebrate Diver - Macroinvertebrate expert or team member tasked with key invertebrate identification and evaluation.

Fish Divers - Usually two divers. Reef fish ecologists or team members tasked with fish identification and evaluation.

Many of these divers will also have to assist with rugosity measurements, underwater photography, damage measurements, evidence collection, etc.

Dave Gulko

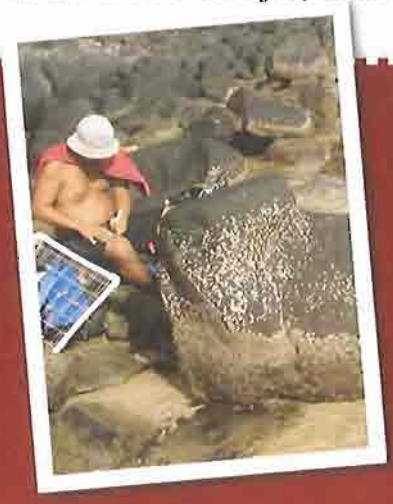
All divers will have practiced in-water techniques under controlled conditions and under stress conditions (note taped mask to simulate zero visibility event).

Beth Lumsden, NOAA

The divers on the team need to be able to complement each other's activities and truly work together while conducting their independent studies, while maintaining a safe diving environment, and while managing the injured site risk management needs both together and on their own.

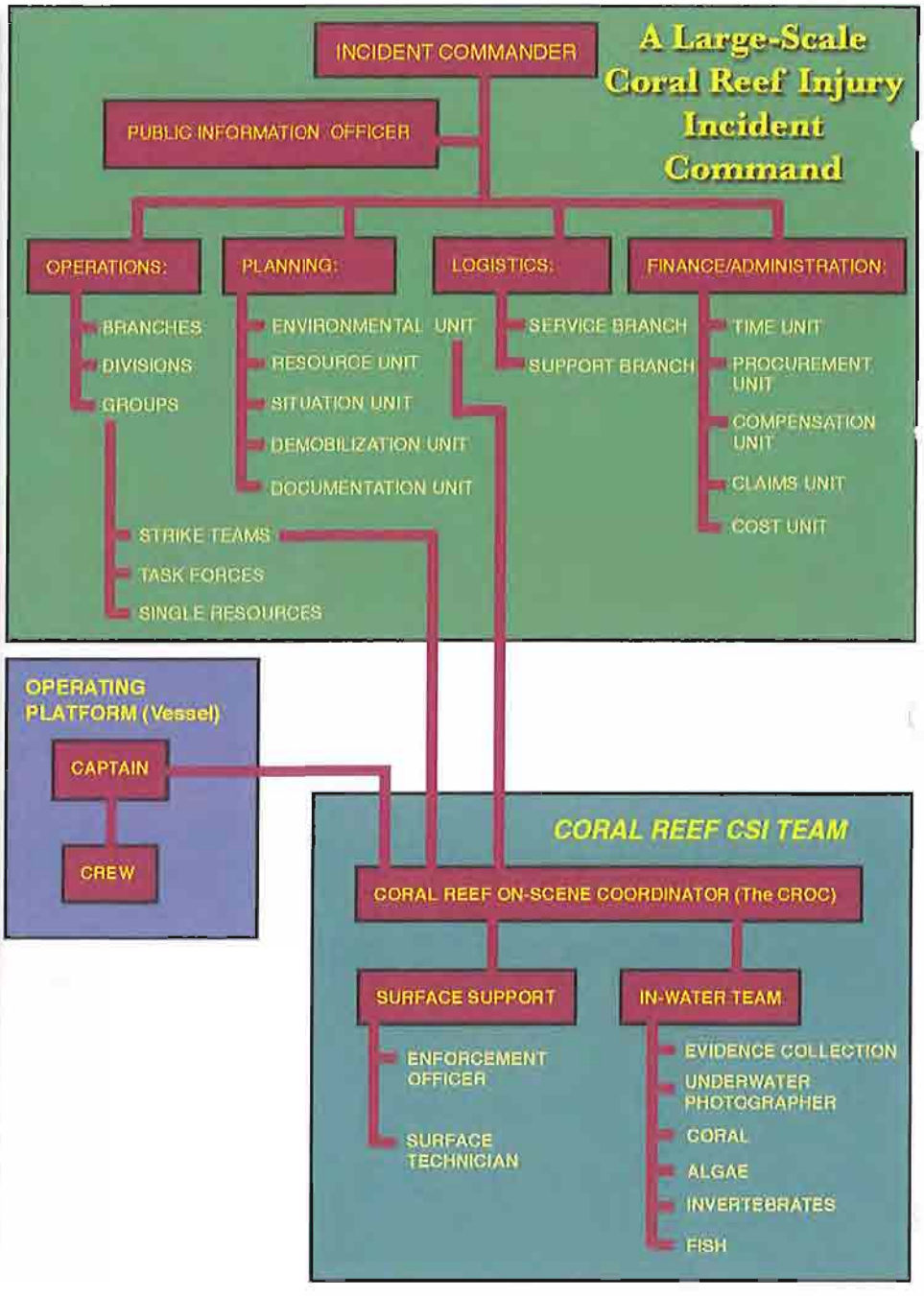
Other Types of Non-NRT Investigators

Note that in-water marine injury investigators need to be associated with NRT agencies such that they have legal authority at some level to access the injury scene and collect data/evidence. At the same time, the RP, the media, researchers, or outside bodies/individuals may wish to access the injury scene with their own investigators. Unless involved in a pre-agreed to cooperative investigative agreement, such parties should not be allowed access to the injury site until after the NRT team has completed its field work. Such guidance is in addition to any public safety, private property, security, or resource protection concerns which might be present.



Concerns & Warnings

- **Too Few Participants:** Results in team members wearing multiple hats, perhaps in areas outside their expertise; increases investigation time; may lead to ineffective or incomplete data/evidence collection.
- **Too Many Participants:** Results in team members decreasing the effectiveness of investigation; increased contamination of the impact event scene, and increases difficulty of risk management & safety issues.

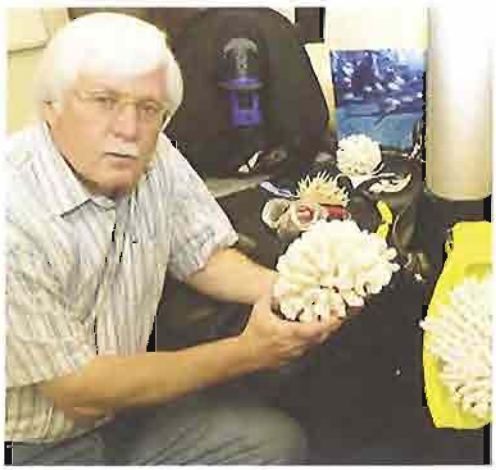


BASIC MARINE INVESTIGATIVE TOOLS

THE NEED FOR TRAINING

The Sea Change in In-Water Investigations

Not that long ago, investigations of injury to coral reefs were done primarily on land, using eyewitness accounts from responders of what happened; in many areas NRT agencies would independently dispense a diver or two to take a look, and make a measurement or two. Rarely were RPs held accountable for the damage caused, mitigation applied, or reef injuries restored.



USFWS

In the last decade, with the recognition of reef declines world-wide, more and more NRT agencies are recognizing the need to treat RP-caused coral reef injuries as they would other natural resource damage cases where a RP is held accountable. This by its very nature requires detailed investigation and evidence collection and NRTs are beginning to recognize the advantages of training professional multi-disciplinary, multi-agency, field investigative teams to accomplish these tasks in a manner that will hold-up before a decision-making body such as a court of law.

Ken Goddard

While many would just jump in the water to begin "investigating", it is critical from both a risk management and evidence collection perspective that all members of an investigative team be properly trained prior to conducting such activities. Training involves far more experience and knowledge beyond training as a SCUBA diver or expertise in any one area. A key component is that all training should be documented and refreshed through training exercises annually.

Beth Lumsden, NOAA

Skills Needed To Be On A Coral Reef CSI Team

At its most basic level, the true measure of success for an operational field investigative team is whether that team comes out of the field at the end of the day intact and without injury. For this to occur, all members must know their roles inside and out, having practiced (to be clear - that means tabletop practice sessions, outdoor (on land) practice sessions, pool or lagoon practice sessions, and actual field practice sessions) together and armed with the skill sets to respond to any contingency or emergency.

Dave Gulko

It is important that all team members have experience in not only accomplishing the various tasks involved underwater in an injury investigation; but most importantly, have experience individually and as a team extricating themselves from both man-made and natural hazards encountered. While not a replacement for true field experience, injury exercises provide excellent training for such contingencies.

Team members should be chosen based upon their abilities, expertise, authorities, and proven capability to function as a part of a team where reliance on team members means the difference between life and death in the field.

That said, all team members should possess certain skills beyond that of standard recreationally-certified divers in order to work underwater on a team. While standards will vary with jurisdiction, a basic core set of standards might include the following:

AWARENESS COMPETENCY

a. Assess impact site & determine platform for the operation (boat, shore, etc.).
b. Assess the site for obstacles & hazards (surface & subsurface).
c. Contact co-trustees and support agencies.
d. Secure the scene.
   • Identify witnesses.
   • Prevent unauthorized entry.
   • Delineate the injured area.
e. Determine entry and exit routes.
f. Assess contamination & biohazard levels.

OPERATIONAL COMPETENCY

a. Stage, rig & check equipment.
b. Reassess obstacles & hazards; contamination and biohazard levels.
c. Select a command site.
d. Determine the need for the dive
   • Cost-benefit analysis
   • Time window issues.
e. Assist in dressing/equipping divers.
f. Calibrate gear (GPS, Cameras, etc.).
g. Assist in deploying divers.
h. Provide dive tender support
   • Direct the dive
   • Monitor communications
   • Maintain assessment or search integrity.
i. Serve as back-up diver or safety diver.
j. Assess the quality of data collected.
k. Maintain chain-of-custody for all evidence collected.
l. Assist in diver recovery and gear removal.
m. Provide decontamination assistance if necessary, clean all gear.
n. Stow gear.

TECHNICAL COMPETENCY

a. Assess obstacles & hazards.
b. Discuss the contamination levels
   • Determine type of equipment to be used - Hazmat or conventional SCUBA gear?
c. Check gear & dress.
d. Discuss assessment and objective(s)
   • Communication/signals
   • Contingency plan
   • Safety gear
e. Deploy
f. Maintain assessment dive integrity
g. Upon surfacing, report hazards
h. Complete all necessary paperwork & analyze data.

Adapted from the U. S. National Fire Protection Association (NFPA) Standards for Rescue Divers and R. Becker (2006).

Pre-Dive & Post-Dive Activities Training

Time should be spent practicing pre- and post-dive activities and contingencies relative to various reef injury scenarios.

Dave Gulko

Team members practice under controlled conditions conducting work around obstacles and in low-visibility conditions (note the blacked-out mask on the diver). At all times during training sessions, support divers are available to assist if needed.

Dave Gulko

Techniques are practiced on land and choreographed under different conditions to deal with various contingencies as might occur under field conditions.

Field Hazards Encountered by Reef Injury Investigation Divers:

HAZARD	COMMON FORMS	SYMPTOMS	STEPS TO MINIMIZE IMPACTS TO PERSONNEL
Sun Damage	• Sunburn • Cataracts, Glaucoma	• Pain; Reddened and/or peeling skin, blistering. • Diminished vision.	• Sun-protective outerwear, waterproof sunscreen with a SPF of 30 or greater • Brimmed hat & polarized sunglasses.
Contaminated Water	• Bacteria (*Leptospirosis, E. coli, V. Cholerae*, etc.) • Viruses (*Hepatitis* A & B, etc.) • Parasites • Harmful Algal Blooms (Red Tide, *Lyngbya sp.*, etc.)	• Fever, Cramps, Diarrhea, Nausea • Flu-Like symptoms, Jaundice • Contact Dermatitis • Infections • Death	• Protective Gear (Dry Suits, duct taped seal, full helmets) • Pre-Dive Water Quality Info • Team Members Immunized. • Post-Dive Decontamination Protocols.
Released Chemicals	• Oil, Diesel, Gasoline • Ichthycides (Chlorox, Cyanide, etc.) • Refridgerents	• Poisoning • Death	• Protective Gear (Dry Suits, duct taped seal, full helmets) • Pre-Dive Water Quality Info • Post-Dive Decontamination Protocols • Non-contact.
Marine Debris	• Fishing Line, Nets, Traps • Sharp metal, glass • Unexploded ordinance	• Lacerations, Cuts • Infections • Death	• Protective Gear (Full Suits, Gloves), Shears • Buoyancy Control • Habitat Awareness • Non-contact.
Hazardous Marine Life	• Sessile Organisms with Sharp Edges (Coral, Oysters, Barnacles, etc.) • Stinging Organisms (Hydroids, Jellies, Fire Coral, etc.) • Biting Organisms (Eels, Mantis Shrimp, Barracuda, etc.)	• Lacerations, Cuts • Stings with Toxins • Infections • Allergic Reactions • Death	• Protective Gear (Full Suits, Gloves) • Buoyancy Control • Habitat Awareness, Care in Disturbed Environments & Restricted Spaces • Non-contact.

It is important to note that for any given injury event, some of the above may be involved, requiring that the divers that respond be specially trained, equipped, and supported to work in such hazardous environments. Such training needs to be specialized for the regions involved and is not covered by the materials in this toolkit.

Multi-Disciplinary vs Single Disciplinary Teams

While base skills are necessary for all team members, the strength of the team will be on its make-up of different advanced skills and expertise. To this end, each team should be composed of investigators with expertise in the fields of corals, algae, fish and invertebrate identification and ecology; marine ecotoxicology, marine forensics, etc. Limitations in expertise will express itself during all stages of the investigation and especially provides openings for exploitation by the RP. Expertise is relative to the ability to specialize amongst members of the team, but should be encouraged and sought wherever possible; that said, each member should train so that if conditions require, they can take over the functions of another team member.

Multi-Agency vs Single Agency Teams

For some jurisdictions, the local laws or agency capabilities may favor the creation of an investigative response from only a single agency. While this is initially preferred by many old-timers in regards to maintaining control over an investigation, providing for an already established chain-of-command, and frequently, because of legislative mandates which often do not encourage cooperative approaches; a well-trained multi-agency team provides for a more robust, transparent and powerful end product, regardless of whether such product is sought in court or through some civil action. The reasons for this rely mainly on the basis that different agencies have different staff expertise, resources, and equipment to provide for an injury investigation; and perhaps most importantly, provide for a defense against a single agency bias thereby enhancing transparency with the public and decision makers. This last point can be very important when cases involve a Responsible Party (RP), as a single agency bias, procedure, or previous association with the RP can be used to inject doubt into the results of an injury investigation. The multi-agency team allows for a pooling of expertise, equipment and authorities in a fashion which is often very transparent and with proper training, extremely productive relative to the documentation of, and collection of evidence from, marine natural resource injury events.

Dave Gulko

The Use of Private Contractors

In some jurisdictions, injury response activities (especially those involving emergency restoration, primary restoration or mitigation) are handled by contractors specifically hired to do the in-water work. This is very different then the investigation aspect which is almost always handled by Natural Resource Trustee (NRT) agencies and/or enforcement, Coast Guard, or military services.

Regardless of the above, the Responsible Party (RP) in a large injury case will often want to hire their own contractors to conduct independent assessments of damage or to accomplish mitigative or restorative work required by the NRTs. While this is often desirable given manpower, expertise, and equipment deficiencies often prevalent with NRT agencies, careful thought and requirements need to be put in place prior to the allowance of contractors to work on an injury site. While the NRT response to an injury is primarily a Public Trust or government function, a contractor's involvement is first and foremost financially driven.

Beth Lumsden, NOAA

While there is nothing wrong with this, the concerns and pressures are often different than, and occasionally at odds with, those of the NRT. Under such a situation, it is possible that the financial arrangement between RP and Contractor, outside of the oversight of the NRT, can lead to NRT concerns in the following major areas:

1. Disturbance or alteration of the injury scene.
2. Misrepresentation of the injury and its recovery potential.
3. Inadequate or substandard mitigative or restoration work.

Often these concerns can be minimized through the NRT maintaining **firm oversight** over all activities involving the injury and NRT Public Trust resources. One way to bring this about in a fair manor is to develop a regional certification or qualification process. The State of Florida (USA) has a process that might serve as a guide. Key points involve the certification or qualification process being based on criteria such as past performance (i.e. formally-documented success); the ability to work effectively with the NRT and other involved agencies; and the documented possession of necessary skills, certifications, or degrees verifying ability and equipment capability to conduct the specified activities.

State of Florida (USA) Guidelines for Use of Contractors (Necessary Qualifications)

A. SCIENTIFIC SUPPORT - Activities consist of environmental project management, site assessment, surveying, mapping, monitoring, and reporting. Qualifications include:

1. Demonstrated skill and experience in successful marine natural resource project management and scientific report writing.
2. An understanding of the specific local habitat(s) and ecological processes involved.
3. Demonstrated experience and knowledge of the current technology for surveying, mapping, assessing, restoring, and monitoring coral reef habitats.
4. Demonstrated knowledge of, and ability to abide by, all rules, regulations and laws involved with the injury and associated habitats and/or natural resources.

B. EMERGENCY RESTORATION - Activities consist of efforts to rescue and protect biological resources prior to restoration. Qualifications include:

1. A demonstrated understanding of the specific local habitat(s) and ecological processes involved.
2. Specific local knowledge of the function and values (economic, cultural, etc.) of the reef habitat(s).
3. Specific knowledge of the biological/ecological requirements and limitations of the organisms being rescued or held for later restoration.

C. ORGANISM REATTACHMENT - Activities consist of reattaching biological resources using various construction materials. Qualifications include:

1. A demonstrated understanding of the specific local habitat(s) and ecological processes involved.
2. Specific knowledge of techniques for handling and re-attaching the specific types of organisms involved in the injury.
3. Specific knowledge of Best Management Practices (BMPs) to minimize impact from all activities undertaken on adjacent substrate and organisms.
4. Demonstrated experience and long-term success in organism reattachment.

D. DEBRIS AND RUBBLE MANAGEMENT- Activities consist of debris removal and disposal, bottom paint and other hazardous material removal, and rubble removal and disposal. Qualifications include:

1. Specific knowledge of environmentally-sound and legal techniques and permitting requirements for safely removing and disposing of debris and bottom paint.
2. Specific knowledge of environmentally-sound and legal techniques, methodology and permitting requirements for stabilizing rubble in the specific affected habitats.
3. Specific knowledge of BMPs for removing and transporting coral rubble and debris to minimize injury to the surrounding environment and organisms.

D. DEBRIS AND RUBBLE MANAGEMENT- Activities consist of debris removal and disposal, bottom paint and other hazardous material removal, and rubble removal and disposal. Qualifications include:

E. REEF FRAMEWORK REPAIR - Activities consist of structural stabilization and reconstruction. Qualifications include:

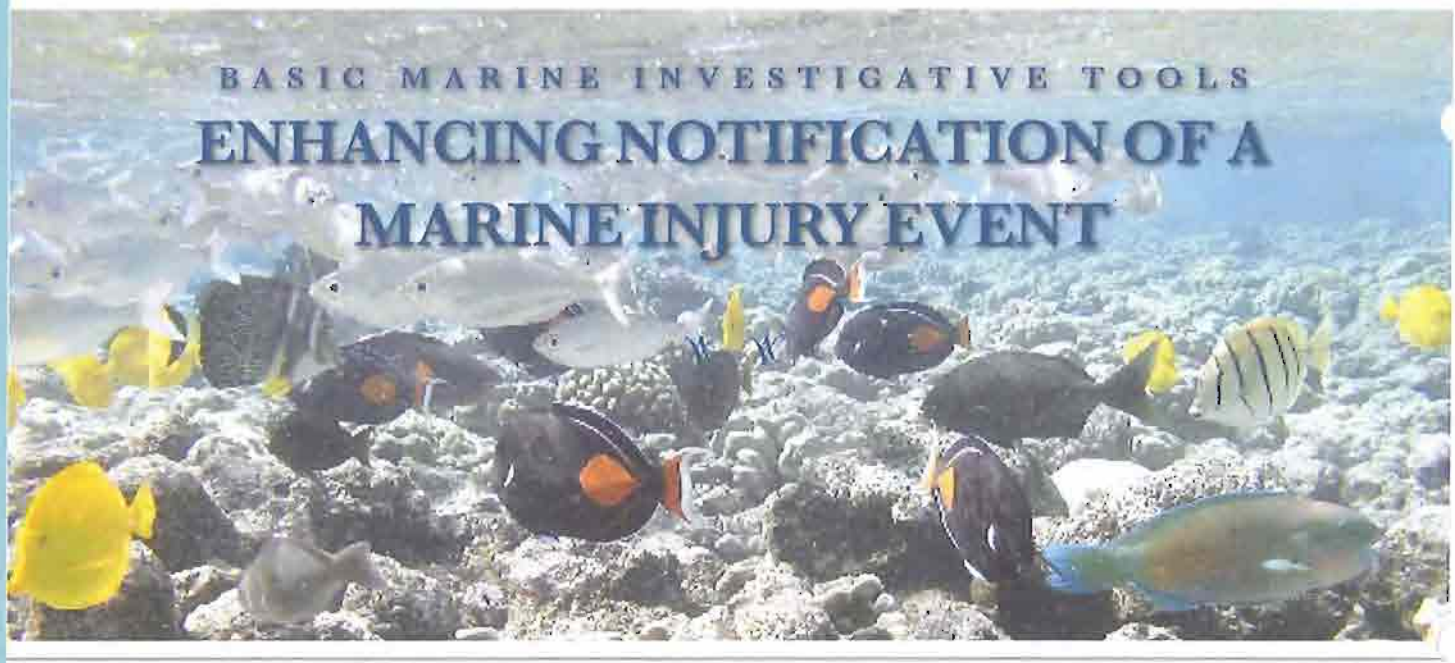
1. A demonstrated understanding of the specific local habitat(s) and ecological processes involved.
2. Specific local knowledge of the currents and water flow patterns that may affect the successful stabilization and reconstruction of the reef framework.
3. Specific knowledge of BMPs for the use of cements, epoxies, or other suitable stabilizing agents in the marine environment to minimize injury to the surrounding environment and organisms.

F. NRT INTERFACE - Activities consist of working with the NRT to incorporate specific resource management concerns into all work activities. Qualifications include:

1. Ability to incorporate the presence of a NRT or enforcement representative as an observer during all activities.
2. A demonstrated understanding of the secondary impact concerns associated with the injury event (such concerns might include topics such as alien species, phase shifts, etc.).

Adapted and modified slightly from the Florida Department of Environmental Protection (2007). Section F (NRT Interface) was not in the original document and was added by us for the CR CSI training toolkit.



BASIC MARINE INVESTIGATIVE TOOLS

ENHANCING NOTIFICATION OF A MARINE INJURY EVENT

The Need for More Effective Initial Reporting of Injuries

Dave Gulko

Within any given jurisdiction, one of the weakest points in any agency's response capabilities is the ability to get timely and accurate news of an injury event.

Dave Gulko

Often members of the public or user groups will not report a injury event or illegal natural resource activity due to one or more of the following:

1. They do not recognize that the activity is injurious or that it is illegal.
2. They do not know who to report it to.
3. They do not know how to report it (i.e. by what means).
4. They do not feel it is in their interest to report it.
5. They feel that reporting the activity could affect their safety or their business.
6. Reporting such events goes against the societal or cultural norms.

A key function of the NRTs is to educate the public (and the repetitive resource user groups

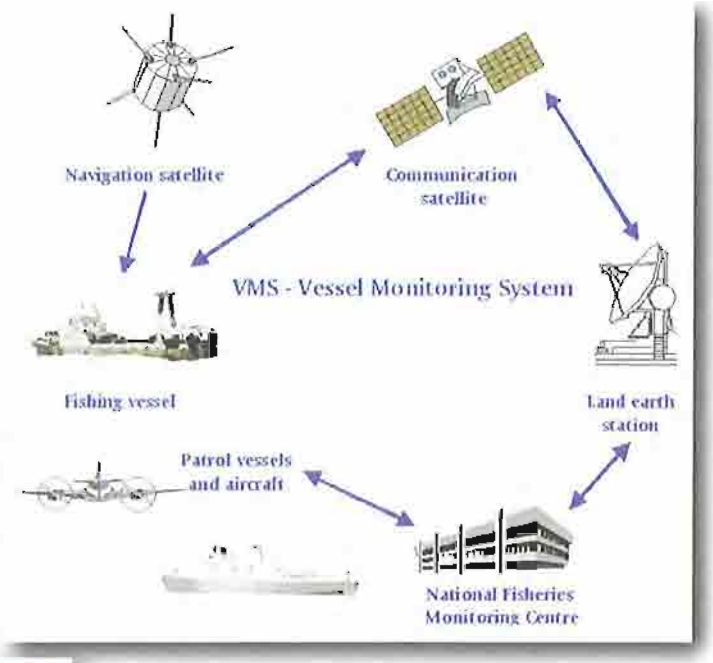
Objectives

- ***To increase the effectiveness of initial response efforts through more effective initial reporting.***
- ***To provide guidelines for questioning reporting parties .***
- ***To provide guidance for improving public knowledge and response to reporting injury events.***

in particular) regarding compliance issues. Efforts should be made to target educational compliance efforts relative to the above concerns.

The Use of Technology for Compliance

Modern electronics associated with vessels allows active compliance monitoring through a variety of means. One of the more widespread methods involves the use of GPS trackers on vessels to monitor both location and activity. These Vessel Monitoring Systems (VMS) are becoming more widespread in regional areas for monitoring large commercial and fisheries ships, but as the technology progresses expect to see its use applied more frequently to small vessels and individual resource users.



European Commission (http://ec.europa.eu/fisheries)

AVRAM (http://www.reefbase.org)

Other major technological advances include a wide range of hand-held devices which greatly enhance the ability to take data and evidence in the field and maintain chain-of-custody. Examples include laser rangefinders, digital cameras with built-in GPS, hand-held radar guns, and field test kits for identifying a variety of chemical pollutants or illegal substances.

Another technical tool has been the use of biomarkers or genetics to identify the origin of suspect evidence gathered during the course of an investigation or for tracking organisms taken for the marine ornamental trade (*above*) or for the live fish trade (*right*). These tools require access to professional laboratories that can be certified relative to related expertise, non-contamination, and chain-of-custody.

AVRAM (http://www.reefbase.org)

Community-Based Compliance Efforts

In many areas, marine land tenure, strong subsistence use of marine habitats, and traditional village/non-industrial economies may result in a village or community having some legal authority over marine natural resources.

Impact Events

NRTs can work with communities to focus their observation and reporting abilities relative to a wide variety of impact events. For those areas with marine tenure, efforts should be made to enhance formal permitting, review, and reporting procedures at the community level. Efforts to establish formal guidelines for response procedures should be done for isolated communities and those with widespread coral reef areas under their authority.

Illegal Activities

Few communities have legal authority to pursue criminal actions against RPs independently, resulting in a need to work closely with governmental NRTs which often have the authority and the resources to conduct such cases. That said, recognized communities may have standing to bring civil cases against RPs for such activities in many regions.

Side Topic: A Couple Words Regarding Bioprospecting

AVRAM (http://www.reefbase.org)

A relatively new issue is starting to rear its head in coral reef impact circles - the use of research exemptions and permits to conduct bioprospecting activities that are either directly or indirectly commercial in nature. Care needs to be taken in evaluating such proposals regarding the amount of specific material requested (dry weight or wet weight?), the specificity of the target organism(s), and the focus on rare or endemic organisms. Additional concerns include access and benefit-sharing provisions with resource owners and communities.

James Oliver (http://www.reefbase.org)

Direct Education Efforts

Often the best way to address compliance issues is through direct education efforts. That said, most resource management agencies rarely effectively target the user groups in need most of compliance education through means designed to effectively reach those groups. In today's world, many agencies take the easy way out and create web sites to educate the public without realizing that websites only tend to be used by those specifically targeting your information (rarely those in need of compliance education). Brochures and pamphlets, while useful in some instances, rarely are the best tool for reaching marine resource users. Putting your message on items that such users frequently use while in the field is a much better (though more expensive) strategy - cup holders, stickers, emergency contact cards, floating key holders, whistles, hats, shirts, etc.

Running short workshops can also be effective if they are engaging and held at times and places where you're likely to get the user group being targeted (i.e. hold it at a harbor not at a hotel). Mandatory courses for violators can also be effective when used as an alternative for minor fines and jail time if done in such a way as to ensure knowledge is received (i.e. testing or have to repeat, etc.).

The Use of Signage to Educate in the Field

In many areas, signage is relatively ineffective as it tends to be too wordy and people outdoors focus little of their time on reading a lot of text; it also requires the target audience to be stationary and relatively close to the sign. Sometimes the most effective signs are those that are highly visual with minimal associated text. Lack of text in signage can be used for marine natural resource compliance education (*above right*), however the lack of contrast in this sign minimizes its effectiveness and clarity. Coloration, contrast, universality, and recognition are all important components. Which of the 'No Swimming' signs below is most effective and why?

Laura Urian, Florida Keys NMS

Compliance Tools in the Field

One of the more prevalent compliance tools present to the public in the field is the use of color-coded surface mooring buoys to control/zone different types of vessels within MPAs and prevent anchor damage. Color-coded surface moorings can be used to zone commercial versus recreational boats, and to control activities of large versus small vessels. Labeled or color-coded surface buoys can also be used effectively to zone MPAs, control vessel movements, deal with over-lapping user group activities. Care needs to be taken with the use of buoys as these can tend to concentrate activities (resulting in unexpected impacts if not carefully monitored and regulated) or can result in targeting of the resources being protected by illegal collection during non-monitored times.

Some jurisdictions are tying their marker buoys to their VMS or remote sensing technologies in order to enforce remote MPA areas.

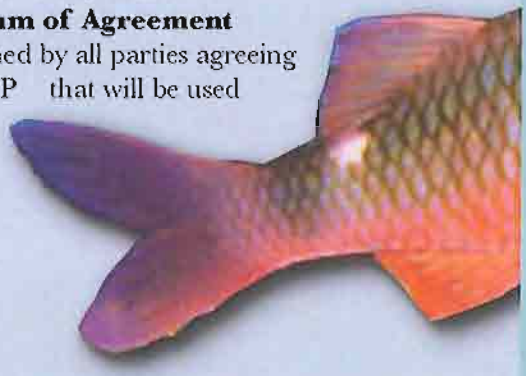
USCG

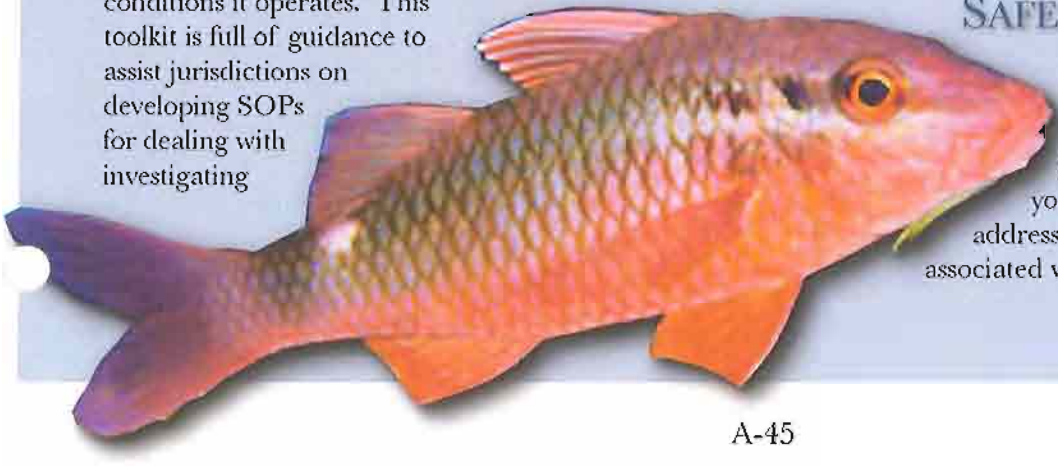
MANAGING AN UNDERWATER INJURY INVESTIGATION

THE BASICS OF FIELDING A IN-WATER INVESTIGATIVE TEAM

There are four basic issues involved with fielding an in-water investigative team to a marine injury event site: Safety & Risk Management; Transportation Issues, Personnel & Equipment Logistics; and Investigative Logistics. Each of these has a series of tasks and considerations associated with them and the sum of all four is often overwhelming for a single individual, especially if the team is composed of multiple agencies with different **Standard Operating Procedures (SOPs)**.

A SOP is often a uniform way that an agency approaches a task or function. Relative to Coral Reef CSI, a SOP is a pre-agreed upon set of rules for how a investigative team performs its tasks and under what conditions it operates. This toolkit is full of guidance to assist jurisdictions on developing SOPs for dealing with investigating injuries to coral reef resources. The best SOPs are those that are clearly defined, written-down, and agreed to before-hand by all involved. When multiple agencies are involved, often a **Memorandum of Agreement (MOA)** is signed by all parties agreeing to a single SOP that will be used while they operate in a coordinated fashion in the field.





SAFETY & RISK MANAGEMENT

Long before your team gets into a real injury investigation you or your agency will have to address safety and liability issues associated with putting employees or

volunteers into underwater injured habitat sites. Basically these questions come down to the following: Have you identified the risks associated with the activity? Have you trained and equipped your personnel to deal with these risks? Have you developed SOPs to deal with the identified risks?

DO YOU HAVE THE ABILITY TO EXTRACT YOUR DIVERS SAFELY AND IMMEDIATELY IN AN EMERGENCY?

Jacek Goliatowsk, Stockxpert

Managing Risk

The following are some suggestions for strategies to manage risk associated with in-water investigations:

Safety Procedures:

- Minimum Skill Requirements, Qualifications, Medical Clearance.
- Required Team Training.
- Analyze all team member assignments to identify possible hazards.
- Plan for, and ensure availability of, evacuation and emergency response protocols and capabilities.
- Ensure that proper safety and emergency response equipment is on-site.
- Maintain field-to-shore and team-to-platform communications. Communications should include ability to request emergency response.
- Thoroughly evaluate site hazards prior to any entry: hazmat, biological, chemical, weather, currents, geological.
- Provide appropriate safety and/or hazmat clothing, gloves, decontamination gear.

Safe Work Habits:

- Use the buddy system
- Have back-up diver or safety divers available on-site.
- Use a safety float to mark diver's position and provide emergency floatation.
- Avoid any confrontations with individuals who may be breaking the law unless trained and authorized to do so.
- Be aware of other team members pre-existing medical conditions.
- Provide appropriate support personnel (dive supervisor, medical officer, equipment technician, security, etc.).
- Ensure tools and equipment are in proper working order and have spares on-site.
- Cease activities if weather worsens or conditions become unsafe.

Modified after J Komoto (2007).

Key Terms

- *Standard Operating Procedure (SOP)*
- *Memorandum of Agreement (MOA)*
- *Risk Management*
- *Hazmat*
- *Operations Platform*

Transportation Issues

Fielding a team often requires multiple forms of transportation which can be used for the following:

- Overview of injury site
- Movement of team to staging area or command center
- Movement of investigative team onto injury site
- Extraction of investigative team from injury site

Frequently the mode of transportation is also used as an operations platform for conducting investigative dives from. Under such circumstances, the operations platform should be equipped with extra air tanks and dive gear, first aid kit and O2 kit, current lines and floats, anchor and line, radio, GPS, compass, water and food. **At all times there should be an operator aboard the dive platform to handle topside logistical and safety needs.**

Personnel & Equipment Logistics

All personnel should have trained together prior to deploying into the field for an investigation. Pre-agreed upon SOPs must be in place prior to anyone entering the water. Deployment should include necessary in-water personnel and surface support.

Equipment should be pre-staged in a secure location. Store all of your electronic gear (cameras, GPS, rangefinder, etc., and spare batteries) in waterproof,cushioned gear cases (Pelican™ cases) that are cable-tied to ensure that the contents are complete prior to deployment. All of your in-water assessment gear can be placed in a wheeled duffel bag labeled "Underwater Assessment" and your evidence collection gear can be placed in a second wheeled duffel bag labeled "Underwater Evidence Collection". Back-ups for dive, assessment and evidence collection gear should be on-site.

It is also important to designate one team member as the equipment manager, responsible for tracking all field gear, making sure it's properly serviced and available for use at the scene.

Personal Protective Gear

Personal protective equipment (PPE) should be used in any situation involving potentially hazardous materials or when diving in habitats posing unknown risks. Obviously, the level of PPE will vary with every injury response. If the response involves the need to handle any injured, deceased, or distressed marine life, team personnel should wear approved PPE to guard against injury or exposure to pathogens.

Recommended PPE for in-water, low hazard injury responses:

1). Full wetsuit with hood, non-skid full foot booties, full gloves (can be duck taped to wetsuit to form a seal).

2). Full eye and nose protection, (i.e., dive mask without purge valve)

3). Ear drops, disinfectant wipes for post-dive; light chlorine solution for dive gear decontamination.

4). Personal flotation device when working on or near water. BCD for diving.

5). Regulator with Safe Second (Octopus) and/or Alternative Air Source.

6). Extra full SCUBA tank with regulator aboard dive platform for emergencies.

7). Emergency signaling device (Dive sausage).

8). Clean, protective clothing to wear before and after dive to protect against sun and temperature and other environmental issues.

ZOONOSES

Many marine organisms may carry pathogens and diseases that are transmissible to people. Diseases that are transmitted from animals to humans are called **zoonoses**. They may be viral, bacterial, fungal or parasitic in nature. They can be transmitted to humans by four primary routes:

1). Inhalation of particles (spores, bacteria) in the air or through intake of contaminated water through regulator.

2). Ingestion of contaminated feces (i.e., projectile feces, poor hygiene, contact with dissolved feces in marine environment).

3). Direct contact with exposed skin and other tissues.

4). Indirectly, via a vector (e.g. wounds from contact with man-made objects (broken glass, metal) or organism bites, stings, punctures).

NOTE: Individuals who have immunosuppressive conditions are more susceptible to contracting zoonotic diseases.

To reduce risk of contracting zoonotic diseases, team members should always: wash hands and other exposed areas thoroughly with soap and water after emerging from the water, wash hands well before and after eating, clean and treat all cuts and scratches, use appropriate PPE.

INVESTIGATIVE LOGISTICS

Prior to deploying in the field, the team should gather all available reconnaissance and intelligence, including charts, aerial photos, investigative reports, blueprints, monitoring studies, atlases, etc. Efforts should be made to coordinate and interview outside agency personnel and experts, along with Public Safety personnel who may have been involved with the initial response.

The Investigative Process Applied to Coral Reef Injuries

In general, the various needs of injury response, public safety, dive team safety, natural resource damage, and public trustee accountability often require that various phases of investigation be conducted in the following order:

A) Incident Reported.

B) Public Safety & Response Elements Activated (if necessary).

C) Incident Command Activated (if necessary).

D) Field Assessment of On-going Damage (may involve SCAT teams).

E) Activate Coral Reef CSI Team.

F) Initiate Field Investigation.

- i) Collect Incident Location and Other Parameters Information.
- ii) Identify Risks & Threats to Public, Field Personnel, Natural Resources.
- iii) Deploy Field Assessment Team.

G) Conduct a Pre-Assessment.

- i) Set Event Perimeter.
- ii) Set Impact Perimeter.
- iii) Define Habitats & Subhabitats.
- iv) Identify & Document Damage Pathways.

H) Conduct an Impact Assessment.

- i) Collect Detailed Damage Measurements.
- ii) Document Resources at Risk.
- iii) Take Photo/Scene Shots.
- iv) Collect Evidence at the Scene.