

Where do the monsters come from? Visualizing marine pollution through biological mutation and game threat design

Changzheng Dai

Wuhan Foreign Language School, Wuhan, China

dcz3297882416@163.com

Abstract. Marine pollution is difficult to communicate because much of it is gradual, distributed, and hidden below the surface. Plastic fragments, chemical residues, and damaged habitats may be present long before the sea looks visibly different. This creates a problem for games: players need to understand danger quickly, while the process itself is slow and difficult to see. This paper examines biological mutation as a design language for making that hidden damage visible. It uses an interpretive visual analysis of three author-generated creature concepts from *Tide: Rebirth*, namely a mantis-shrimp-like creature, a yeti-crab-like creature, and a whale-like creature. The analysis focuses on recognizable anatomy, abnormal color, altered proportions, contaminated surface material, structural imbalance, and the relationship between the creature and its environment. The discussion shows how each design can communicate a different aspect of pollution: contamination and aggression, long-term accumulation, or ecological damage at a larger scale. These observations are not measured evidence of player learning. They describe how creature design can combine visual threat with environmental storytelling. The paper argues that a pollution monster becomes more meaningful when its frightening features have a readable source and when its body, behavior, and surroundings point toward the same damaged history.

Keywords: marine pollution, biological mutation, creature design, environmental storytelling, game threat design

1. Introduction

Marine pollution is easy to name but difficult to imagine. A photograph of a plastic bottle gives the problem a clear object, yet it says little about slow accumulation, chemical exposure, or damage below the surface. In many places, the most serious changes are not dramatic at first. They are scattered, delayed, and mixed into an environment that still appears ordinary. Previous work on marine-pollution communication also suggests that visualization, simulation, and serious games can make dispersed environmental problems easier to discuss and experience [1-3].

Games make this gap more noticeable. Players read a scene while they are moving, making decisions, and watching for danger. A paragraph of explanation can be useful, but it cannot do all of the visual work. The

creature, the water around it, and the way the encounter unfolds have to communicate together.

A practical starting question is therefore: what would pollution look like if it had to be understood in the few seconds before a player chooses to approach or retreat? One answer is to begin with an animal that the player can recognize and then push selected features beyond normal variation. A shell may swell, a surface may collect residue, or a familiar color may turn toxic and strangely bright. The animal remains identifiable, but the change gives the player a reason to be uneasy.

The creatures in *Tide: Rebirth* are designed with this double role in mind. They are enemies, but they are also traces of what happened to the sea. Their bodies suggest an environmental history: exposure, accumulation, physical stress, and ecological imbalance. This is why the mantis-shrimp-like, yeti-crab-like, and whale-like forms matter as a group. Each one keeps enough of its original animal to be read, while the damage changes the meaning of that recognition.

This paper asks how pollution can be translated into creature design, how a player may read abnormality from a few visual cues, and how a monster can support world-building without becoming a detached horror prop.

Pollution usually has no single moment that explains everything. It accumulates in water and sediment, moves through food chains, and changes the conditions in which organisms live. Some effects are visible on a body; others are inferred from behavior or from the surrounding habitat. A game cannot always explain this process at length, so the design has to select a small number of signs that carry more than one meaning.

The problem is not simply to make an organism frightening. The problem is to make the fear legible. Ideally, a player should be able to read three things from the encounter: the creature is abnormal, it presents a real danger, and its condition is related to the place where it appears.

Based on this problem, the paper focuses on five questions: why biological mutation is suitable for representing marine pollution; how players decide that a creature is abnormal; what information color, body shape, physical damage, and unusual structures can communicate; how a monster can look frightening without becoming a random collection of grotesque details; and how visual threat can support world-building and environmental storytelling.

These questions connect an environmental issue to a design decision and then to player action. In the model used here, pollution becomes a change in the body; the change becomes a visual signal; and the signal helps the player decide what to do.

The analysis focuses on the visual translation of pollution into a damaged body rather than on the general psychology of monsters. Methodologically, this is an interpretive visual analysis of three author-generated concept images, not a controlled player study. The images are read alongside ideas from creature design, environmental visualization, visual metaphor, threat perception, and environmental storytelling. This gives the discussion a clear limit: it can explain what the designs are trying to communicate, but it cannot measure whether players actually receive the message.

The research objects include polluted organisms and mutated creatures in games; visual signs of mutation, including color, form, body structure, material, and scale; the relationship between a creature and the environmental danger it represents; and the creature designs in *Tide: Rebirth*, especially the mantis-shrimp-like, yeti-crab-like, and whale-like forms.

A creature becomes meaningful as a monster when its changes have a reason within the world. Making an animal larger, darker, or more disgusting can create an immediate reaction, but those choices are not enough by themselves. In the three designs discussed here, residue, damaged surfaces, altered proportions, and abnormal growths are meant to suggest exposure and ecological stress. The explanation does not need to be a literal biological account. It does need to feel consistent with the environment that produced the creature.

In a game, threat is also a piece of information. A player uses the silhouette, posture, movement, and visible anatomy to decide whether to approach, hide, fight, or leave. Horror is part of that experience, but a useful creature gives the player a quick sense of what kind of danger it represents. Oversized claws imply a direct attack. A dripping surface implies contamination or unsafe contact. A huge body changes the player's sense of space before the creature even moves.

The designs are symbolic rather than scientific reconstructions. They do not claim that real mantis shrimp, crabs, or whales would mutate in exactly these ways. Even so, the symbolism depends on recognition. The player should first see a crab, shrimp, or whale and only then register that the animal has been pushed into an unhealthy state. Believable visual logic is more useful here than biological precision.

2. Literature review

2.1. Marine pollution visualization and serious games

Studies of marine-pollution communication provide a useful starting point because they deal with the same visibility problem. Hellevik and Cyvin discuss how visualization can support public and policy conversations about marine plastic pollution, including its distribution, risks, and uncertainty [1]. Tiller and colleagues examine serious games through ocean literacy and the microplastics governance game *MoreGoJelly!* [2]. Alves and colleagues bring together scientific, societal, and pedagogical approaches to make marine-pollution issues more accessible to different audiences [3]. Fjællingsdal and Klöckner show how board games can support dialogue and simplified environmental communication [4].

These sources do not evaluate the three creature concepts, and they are not used as proof that the designs will change player behavior. They establish a broader communication context. Pollution can be mapped, simulated, discussed, and experienced. The monster is one more way of giving an otherwise dispersed process a concrete form.

2.2. Visual metaphor, environmental storytelling, and threat perception

Begy's discussion of experiential metaphors is helpful because it treats game meaning as something players encounter through action, not only through dialogue [5].

This is where the mutated body becomes a visual metaphor with practical consequences. The same mark that suggests contamination can also identify a weak point, a contact hazard, or a change in the creature's attack pattern. The metaphor is not separate from the mechanics; it is carried through them.

Environmental storytelling treats spaces, objects, and visible traces as parts of a narrative. Abatangelo describes environments as active sites of storytelling, where players assemble meaning from spatial clues and encounters [6].

For example, a monster placed beside dark water, broken industrial equipment, dead marine life, or layers of waste feels different from the same monster placed in a clean open sea. The body becomes one clue among several. Its condition helps the player infer what happened to the location.

Color is one of the quickest signals available during play. Geslin, Jégou, and Beaudoin show that brightness, saturation, and contrast can shape emotional responses in games [7]. Isakov's discussion of digital horror is useful for a second reason: it links fear to abnormality, unfamiliarity, and incomplete knowledge [8]. In practical terms, an unhealthy palette can suggest contamination, while an impossible structure can create discomfort before the player has a name for it.

These ideas are not recipes. They are lenses for reading the designs. A bright patch may draw attention to a dangerous organ, but it may also simply become decoration if the rest of the creature does not support that

reading. The visual cue gains force when color, shape, material, and behavior point in the same direction.

3. Main body

This study treats pollution as a set of changes that accumulate on and inside the organism. The useful design question is not "How can this animal look grotesque?" but "What has happened to this body, and which part of that history can the player see?" This shift keeps the mutation connected to cause, time, and place.

3.1. Visual language of mutation

Color often provides the first break from the normal animal. Darkened tones, dirty whites, toxic greens, unhealthy purples, or small areas of fluorescence can suggest chemical exposure or tissue damage. The exact color is less important than the contrast with the animal's expected appearance.

A familiar silhouette can therefore survive while the palette quietly changes its meaning. The player still recognizes the animal, but the colors suggest that it no longer belongs to a healthy environment [7].

Proportion is another direct way to show that the body has changed. An oversized head, an inflated torso, an extra limb, a twisted tail, or an uneven shell can all make the creature abnormal. The original species should remain visible enough for the comparison to work.

There is a narrow balance here. If every feature is transformed, the creature loses its point of reference. If almost nothing changes, the pollution remains invisible. The strongest designs usually keep one or two stable identity markers and disturb the rest selectively.

Residue gives pollution a physical presence. Sticky fluid, crystals, corrosion, attached debris, and rough sediment make the player imagine a surface that would be unsafe to touch. Unlike color alone, material also implies duration: something has collected, hardened, or stayed on the body.

This sense of accumulation is important to the theme. The creature does not look as though it has merely been painted with a warning color. It looks as though it has lived inside the damaged condition for a long time.

Structural imbalance works at a deeper level. Exposed organs, misplaced joints, asymmetrical shells, or limbs growing in the wrong direction make the animal feel physically unreliable. These details can also hint at behavior. A distorted claw may signal how the creature attacks, while an unstable body may suggest a different rhythm of movement [5].

The effect depends on restraint. Too many abnormalities compete for attention and make the design noisy. A small number of clear disruptions can carry more meaning than a surface covered with random damage.

3.2. Case study: creature designs in tide: rebirth

3.2.1. *The mantis-shrimp-like creature*

The mantis shrimp is a productive starting point because its real anatomy already carries an aggressive visual identity. The claws, segmented body, and forward-facing posture suggest attack before any mutation is added. In the *Tide: Rebirth* concept, those recognizable features remain, but the surface is pushed toward contamination.

The palette is dark and cold, with small areas of glow that pull the eye toward the damaged body. The shell is uneven and material hangs from it. The claws still dominate the read, so the creature communicates an immediate physical threat. The residue then adds a second message: this is not simply a larger animal; it is an animal that has been changed by its surroundings.

The design works through a short movement from recognition to doubt. The player can first think, "That looks like a mantis shrimp." The next thought is more uneasy: "Why does it look like this?" That pause is the

environmental meaning. Familiarity gives the mutation something to interrupt.

3.2.2. The yeti-crab-like creature

The yeti-crab-like creature uses a slower visual rhythm. Its pale shell, heavy body, and attached layers make it appear partly buried in the habitat. There is no single claw or spike that carries the whole threat. The weight of the body and the amount of material on it do that work together.

The pale shell can suggest sediment, mineral deposits, or biological growth. The hanging material makes the creature look wet and poorly maintained, almost as if the habitat has settled onto its body. It seems less like an animal that has just been injured than one that has adapted to an unhealthy place.

That quality makes the creature a useful image of slow pollution. Its danger is not limited to a possible attack. It also implies that the damage has become part of the habitat and may not be easy to remove.

3.2.3. The whale-like creature

The whale-like creature relies on scale and reversal. A whale usually brings to mind open water, long movement, and a relatively calm emotional register. Turning that familiar image into a massive polluted body makes the environmental loss feel larger than the individual animal.

The long body and tail keep the reference to a whale, while spikes, attached organisms, leaking material, and damaged areas make the form unstable. The result suggests that pollution has reached an ecological scale beyond a single organism. The creature is no longer only an animal; it is evidence that the wider ocean has been affected.

Its size also carries gameplay information. Before an attack begins, the player may already be looking for cover or an escape route because the creature occupies so much of the frame. Scale changes movement decisions. It is not just a dramatic visual effect.

3.2.4. Case study summary

The three concepts take different routes to the same subject. The mantis-shrimp-like creature emphasizes aggression and surface corruption. The yeti-crab-like creature emphasizes weight, sediment, and long exposure. The whale-like creature emphasizes scale and the loss of a familiar ocean symbol.

What links them is not a shared color scheme or a single monster formula. It is the relationship between the original animal, the visible damage, and the place in which the player meets it.

4. Results and discussions

The comparison supports five design observations, although these observations should not be mistaken for measured player results:

A mutation reads more clearly when the design gives it an environmental cause rather than a pile of unrelated deformities.

Keeping a recognizable part of the original animal makes the shift into abnormality easier to notice.

Color and surface material communicate visible contamination, while proportion and structure can suggest damage that reaches deeper into the body.

Threat grows through the combination of silhouette, offensive anatomy, movement, scale, and visible damage, not through size alone.

A creature contributes to environmental storytelling when its body, behavior, and surroundings point toward the same history.

These observations also explain why creature design cannot be isolated from level design. The same monster can mean contamination, disease, or simple fantasy depending on the space around it.

4.1. Visual threat and player information

A player often reads the broad silhouette before noticing surface details. Large claws, a wide body, an unusual tail, or an oversized head can establish the first impression. That first impression needs to be clear enough to support a decision, even if the player never studies the creature closely.

Color and material add a second layer. A wet dark body may feel dangerous, while a pale shell covered in deposits may suggest a slower and more embedded problem. These cues work through comparison with familiar animals and with the visual condition of the environment.

The third layer is context. A creature in polluted water, beside broken machinery, or among dead organisms does not feel like an isolated design exercise. The player starts to connect the body to a larger environmental condition.

Visual threat is therefore useful even when it does not produce a direct scare. It gives the player a quick working model of the world: what has changed, what might happen next, and what kind of response could be sensible.

4.2. Discussion and limitations

There are also clear risks. A dramatic monster may leave the player remembering only the horror and not the pollution. A fictional mutation can look scientifically convincing even when it is not realistic. And residue, bright colors, or exposed organs can become empty decoration if they are not supported by the setting or by the creature's behavior.

The best balance is between impact, readability, and a believable environmental history. The design does not need to behave like a biology textbook. It does need to make the player wonder what happened and offer clues through the body, the habitat, and the encounter.

5. Conclusion

Marine pollution is difficult to communicate because much of it is gradual, distributed, and hidden. Mutation gives that process a body that a player can see. By changing a familiar animal's color, proportions, material, and structure, a game can make an environmental problem present in the encounter rather than leaving it as background information.

The three *Tide: Rebirth* concepts show different versions of this strategy. The mantis-shrimp-like creature turns aggression into a sign of contamination. The yeti-crab-like creature makes accumulation and long exposure visible. The whale-like creature expands the idea from one damaged body to an ocean-scale loss.

The designs remain interpretive. They do not prove that players will learn more from monsters, and they do not replace scientific explanation. What they offer is a practical visual language: the creature can threaten the player while also showing something about the damaged world that produced it.

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