Sewage From Anchored Ships Is Damaging Spratly Reefs

Analysis By Simularity

July 12, 2021

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Excess Nutrients

Phytoplankton and algal blooms are caused by excess nutrients in the water. These are seen primarily along coastlines, with the extra nutrients coming from runoff from fertilized agricultural areas, erosion of riverbanks, land clearing, and **sewage effluent**.

In the Spratly and Paracel Islands, there are no runoffs from fertilized agriculture, erosion of riverbanks, or land clearing. There is, however, **sewage effluent**.

Areas of increased nutrients from sewage effluent are seen on satellite images as areas of increased Chlorophyll-a.

Sewage effluent sources in the Spratly Islands include ship wastewater and human habitation without sufficient sewage treatment. **When the ships don't move, the poop piles up.**

Image source: unknown ship from Marine Executive

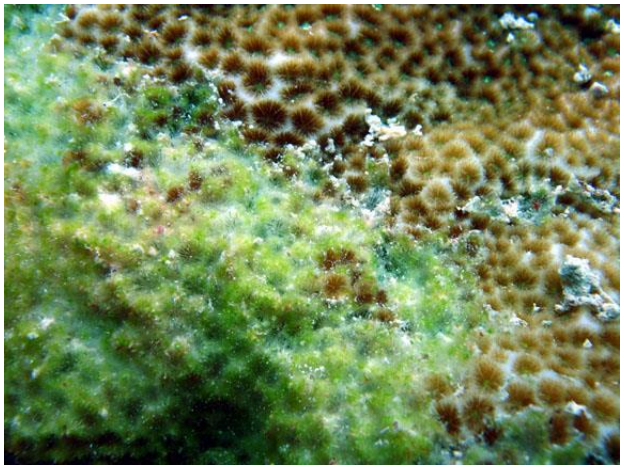
Sewage Leads To Excess Chlorophyll-a

Excess nutrients in the water increase the Chlorophyll-a concentration. Chlorophyll-a is produced by plants of all sizes.

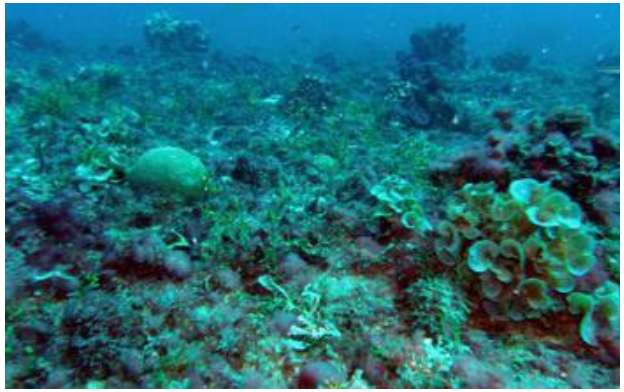
Chlorophyll-a Concentration can indicate harmful algae activity and is a generally accepted measure of water quality. It can be observed and measured in multi-spectral satellite images.

In water, Chlorophyll-a concentration is a measure of **phytoplankton**. Excess phytoplankton that cannot be consumed by the reef inhabitants dies off and sinks to the sea floor, where it is consumed by bacteria. These bacteria consume oxygen that would normally be available to the fish, creating a "**dead zone**".

On reefs, Chlorophyll-a concentration is a measure of the amount of **plant material, such as "fleshy algae"** on the reef. Excess nutrients can speed the growth of "fleshy algae" that can overtake the coral and **destroy** the reef habitat.

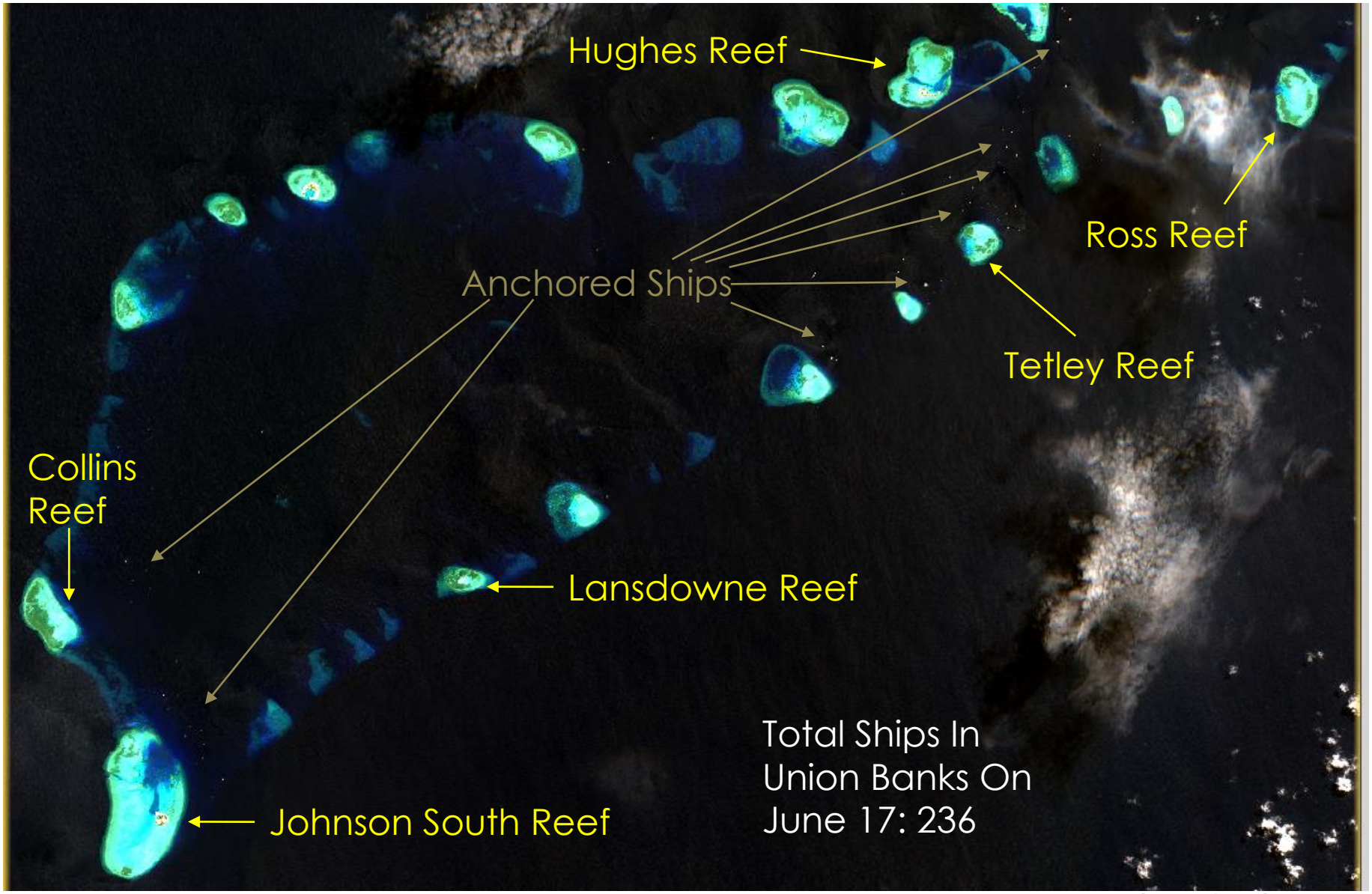


Coral slowly being overgrown by fleshy algae.
Credit: *Jennifer Smith*



A degraded reef dominated by fleshy algae in the Line Islands.
Credit: *Jennifer Smith*

Orientation: Union Banks June 17, 2021



Imagery credit: European Space Agency – produced from ESA remote sensing data

Anchored Ships Creating Chlorophyll-a Blooms In Union Banks

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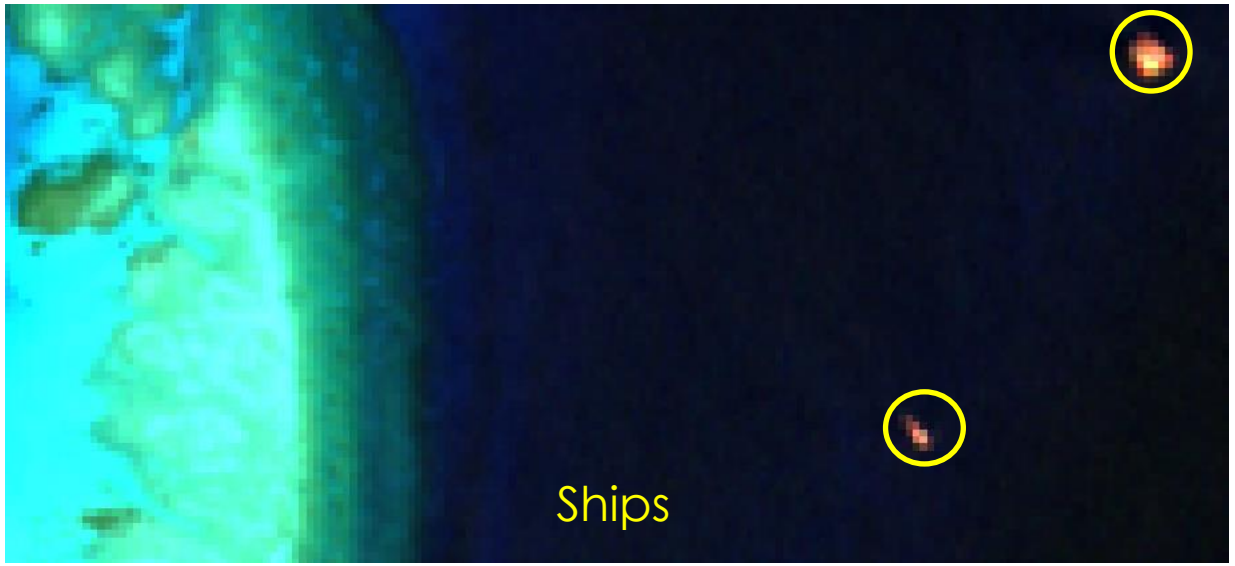
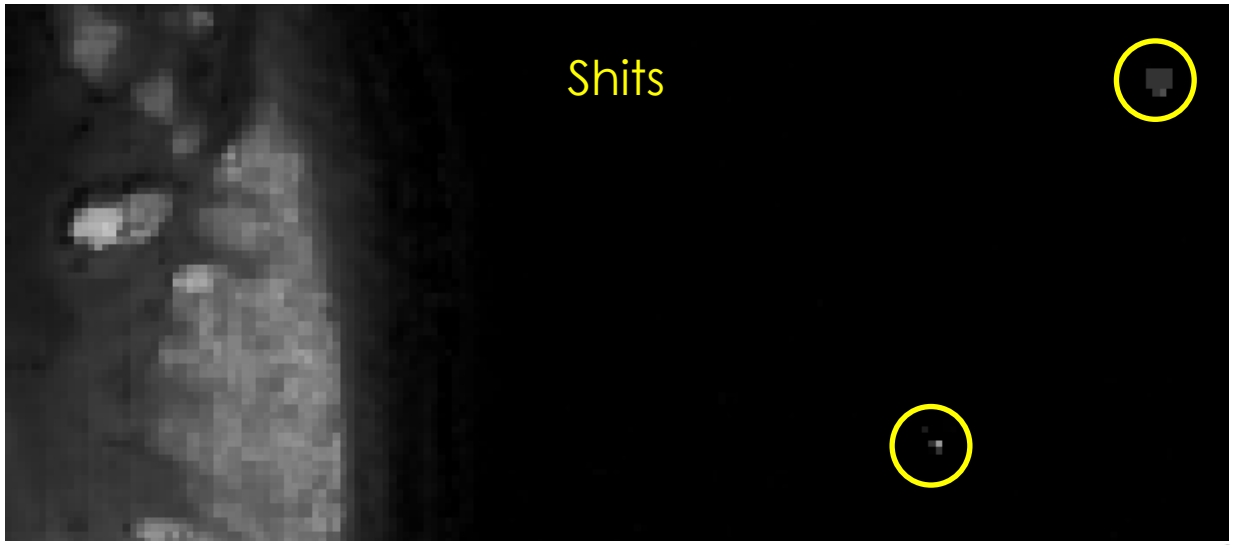
Detail Of Johnson South Reef June 17, 2021

Chlorophyll-a Concentration





Imagery credit: European Space Agency – produced from ESA remote sensing data

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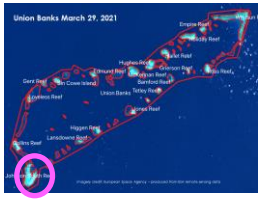
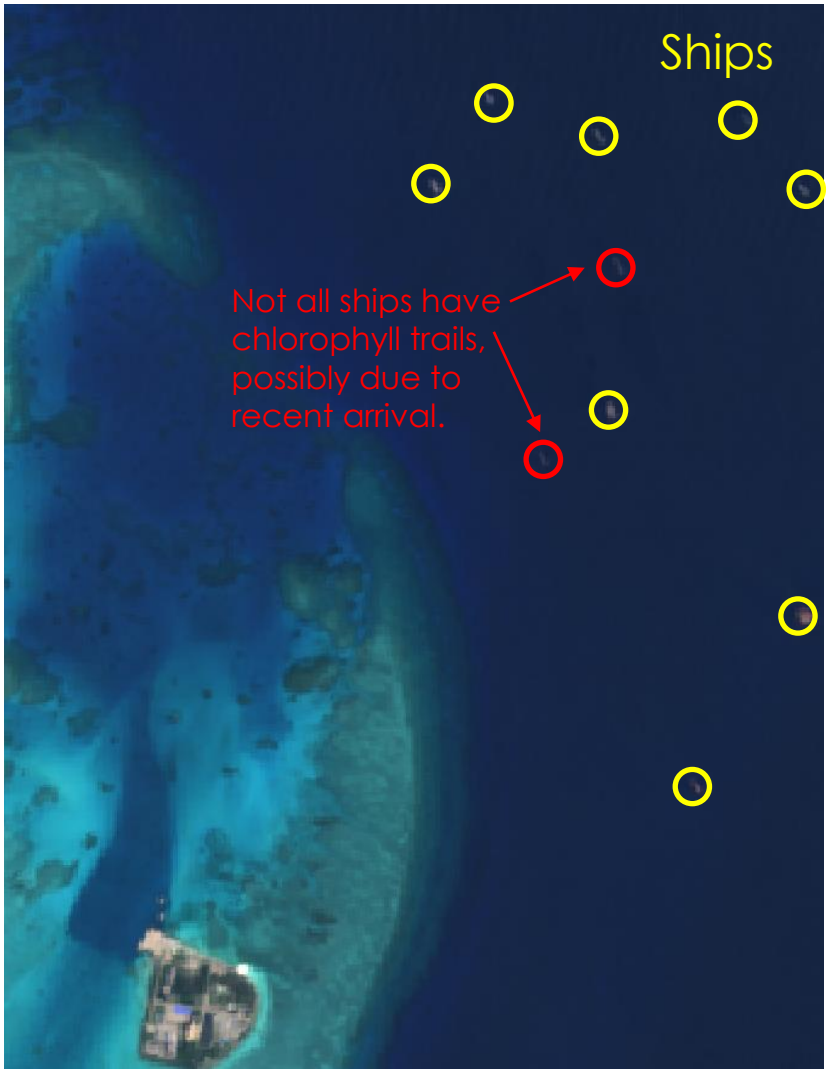
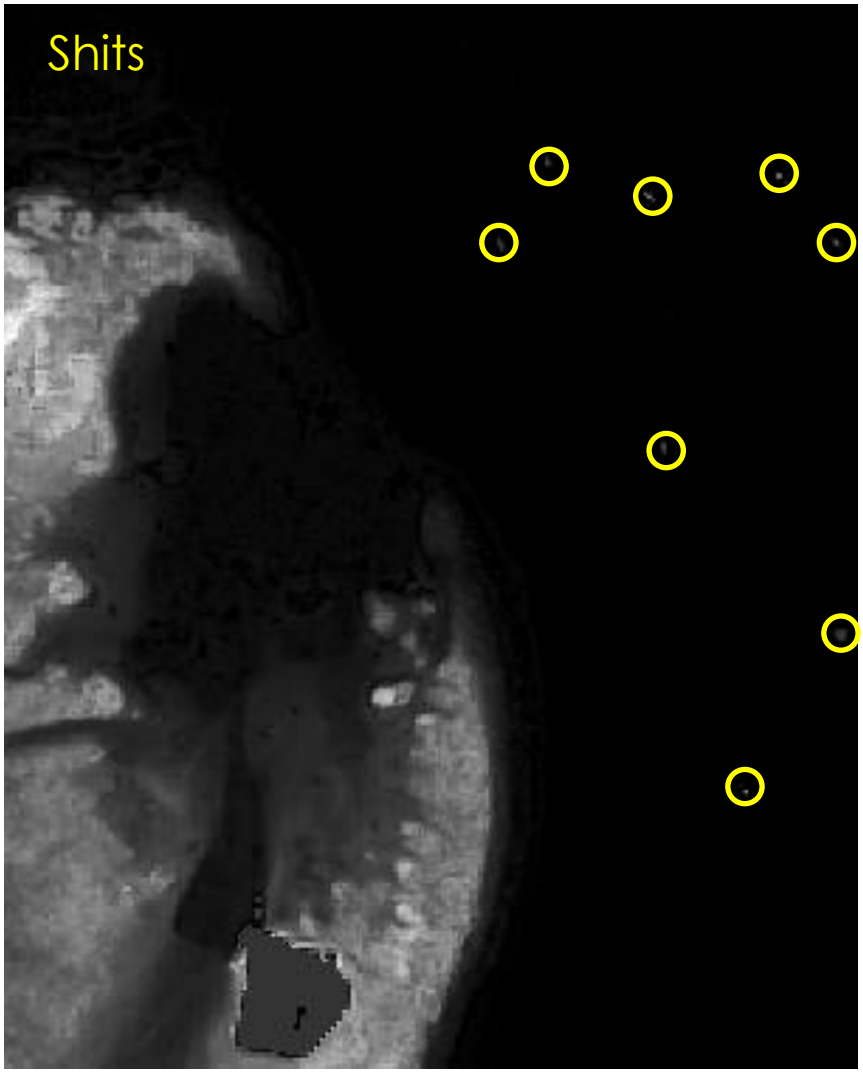
Union Banks June 17, 2021, Johnson South Reef

Chlorophyll-a Concentration







Imagery credit: European Space Agency – produced from ESA remote sensing data

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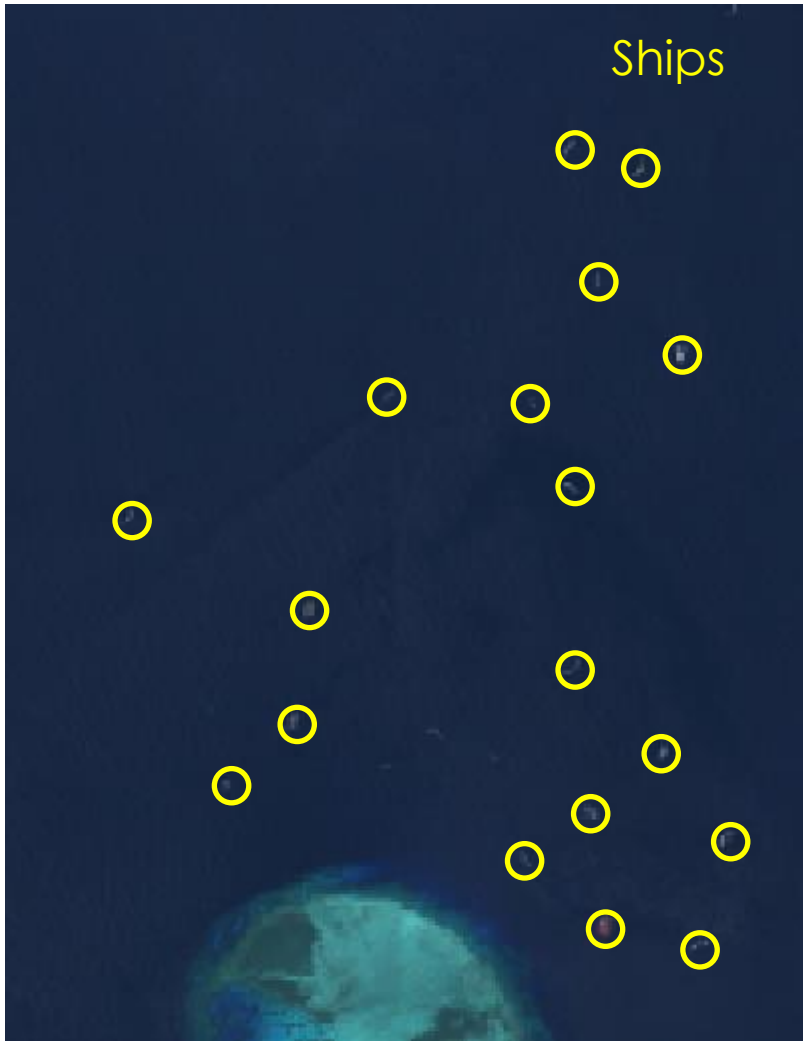
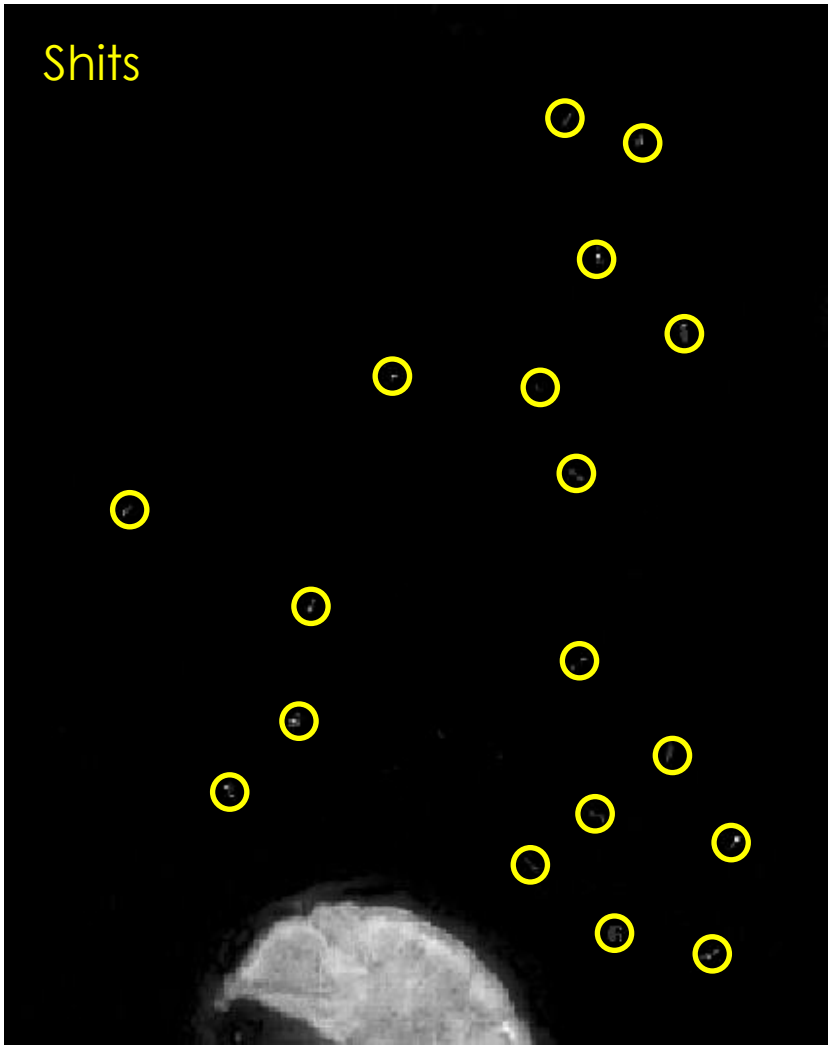
Union Banks June 17, 2021, Tetley Reef

Chlorophyll-a Concentration





Imagery credit: European Space Agency – produced from ESA remote sensing data

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Union Banks Reef Damage By Plants and Algae

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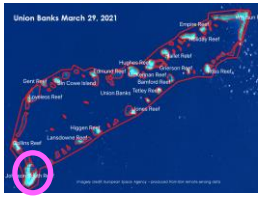
Johnson South Reef: Chlorophyll-a Concentration



May 14, 2016

June 17, 2021

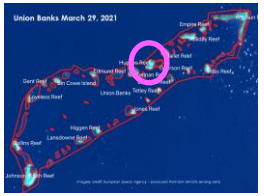
Notice:

- loss of dark areas (where there used to be lack of chlorophyll)
- increasing overall light areas (indicating increased chlorophyll)
- loss of differentiation as plants overtake distinctive reef features

These indicate overgrowth of algae in the last 5 years.

Imagery credit: European Space Agency – produced from ESA remote sensing data

Hughes Reef: Chlorophyll-a Concentration



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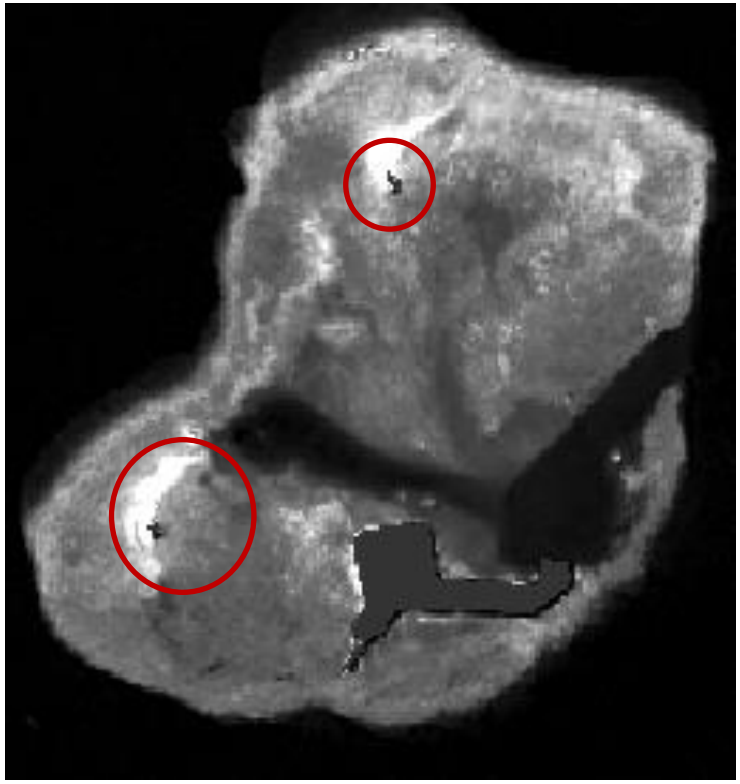

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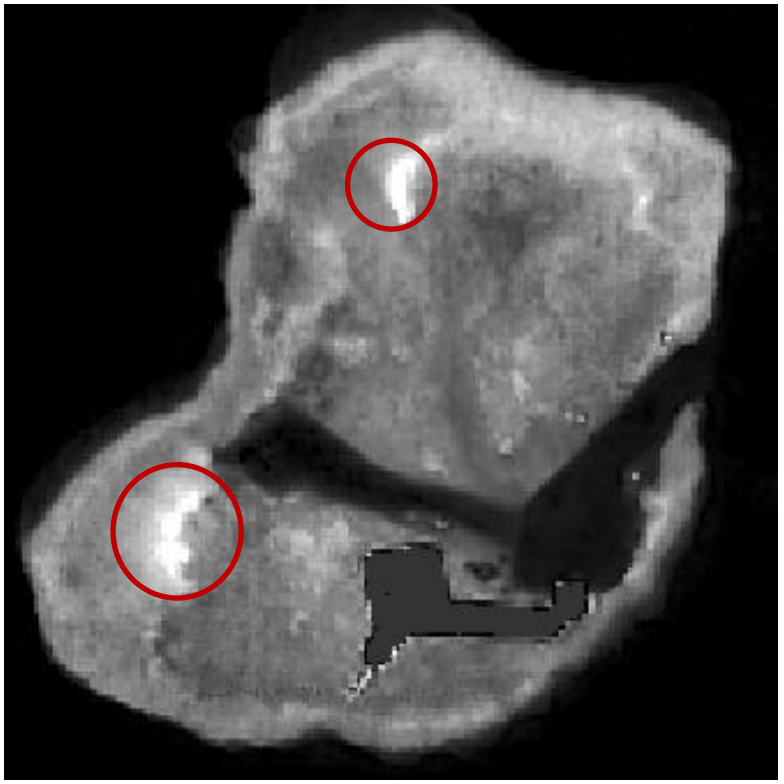

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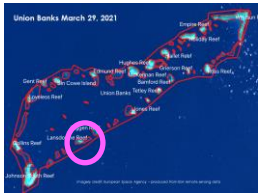
Imagery credit: European Space Agency – produced from ESA remote sensing data

Lansdowne Reef: Chlorophyll-a Concentration



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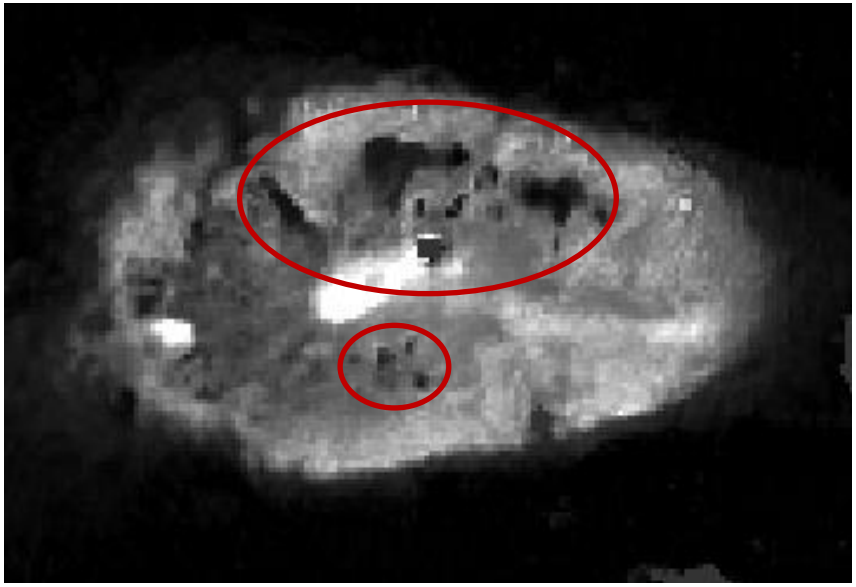

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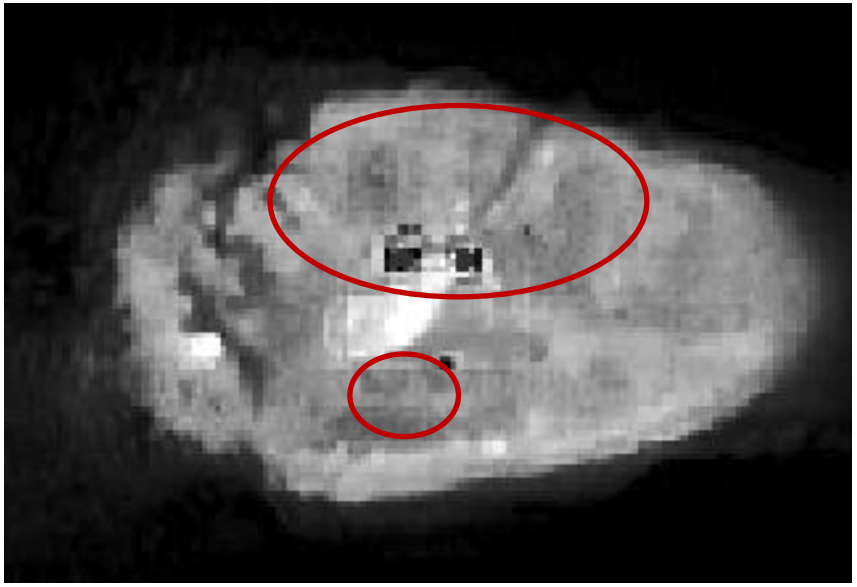

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Imagery credit: European Space Agency – produced from ESA remote sensing data

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Ross Reef: Chlorophyll-a Concentration

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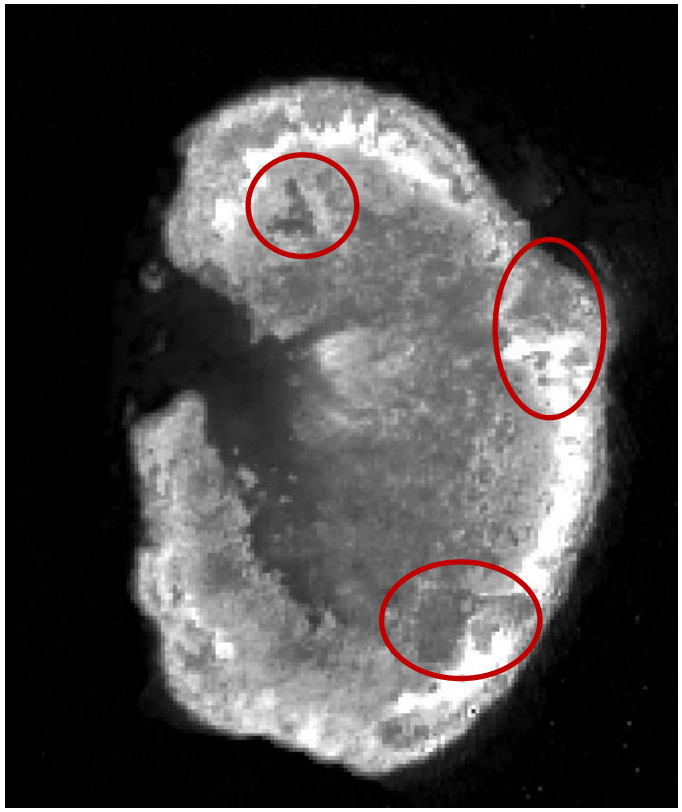

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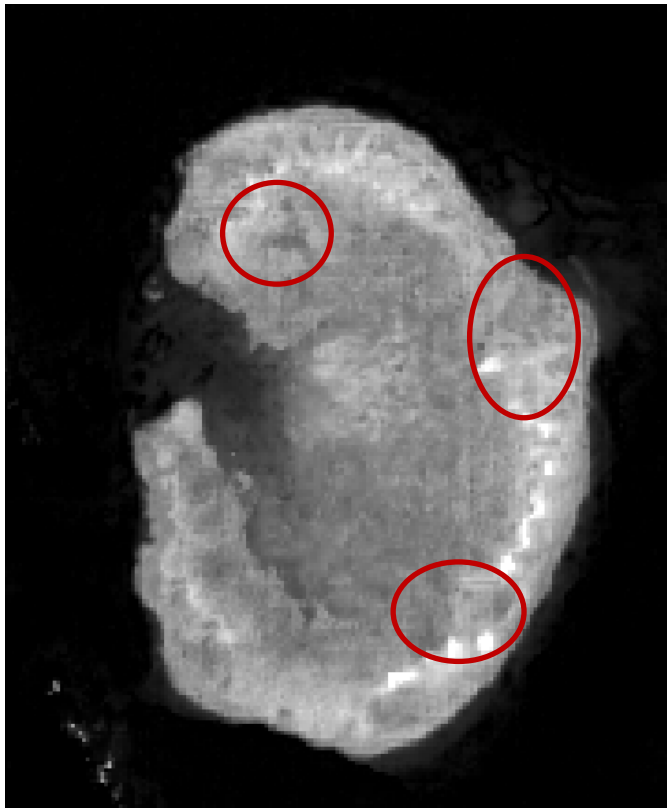

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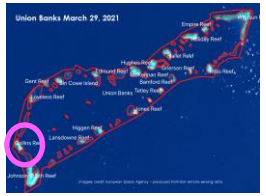
Imagery credit: European Space Agency – produced from ESA remote sensing data

Collins Reef: Chlorophyll-a Concentration



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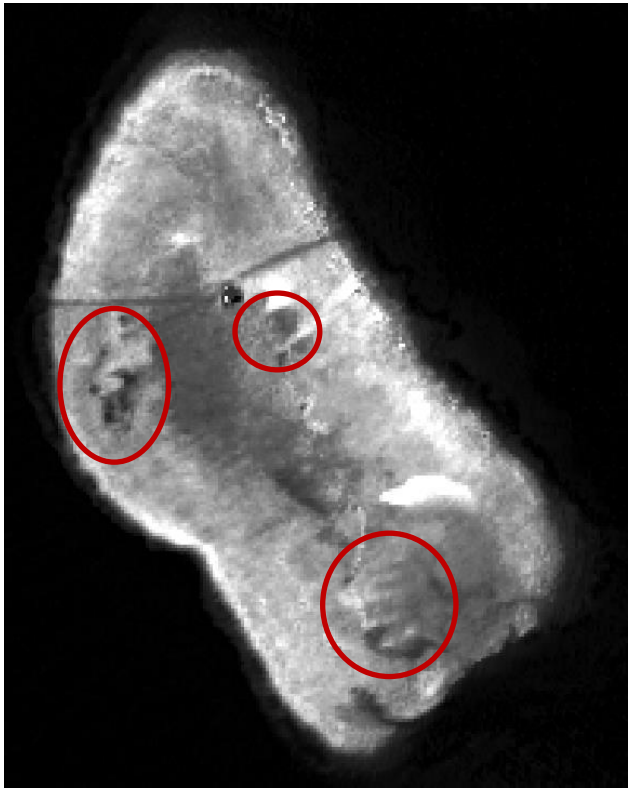

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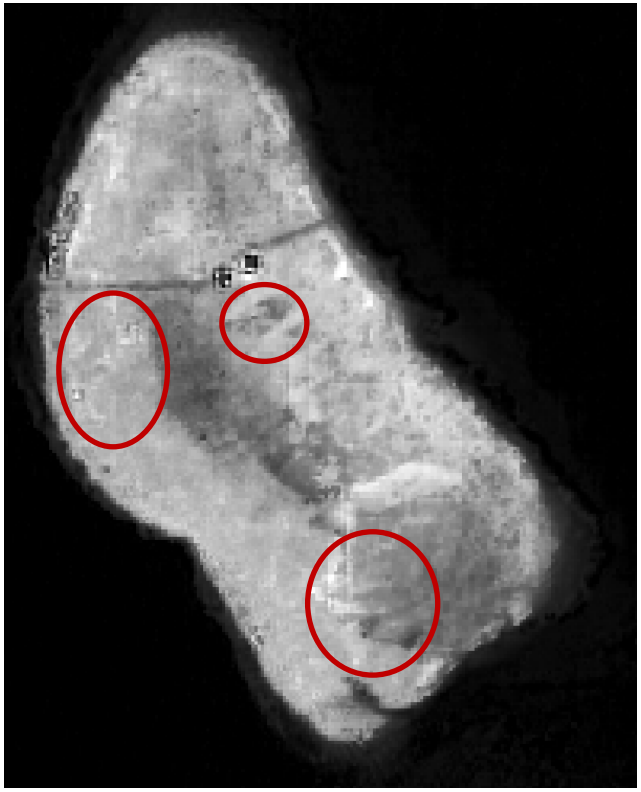


June 17, 2021

Imagery credit: European Space Agency – produced from ESA remote sensing data

It Gets Worse: Cascades of Reef Damage

Healthy coral reef ecosystems have a delicate balance between the organisms and plants that inhabit the reef. **Even small increases** in nutrients can tip this balance towards algae. But that's not all…

Overfishing the waters near coral reefs removes the primary algae-eaters from the environment, allowing populations of fleshy algae to explode. Fishers' use of rocks as **anchors** lowers coral cover, giving further competitive advantage to the algae.

Fleshy algae on reefs **release** copious amounts of **nutrients**, which microbes eat. These **microbes then endanger corals by depleting oxygen** from the environment or by introducing diseases. As the corals die off, the algae have even more space to take over, leading to further coral **mortality**.

Tipping the balance towards algae results in **increased acidification** of the water, increasing coral erosion. This is in addition to the increased ocean acidification caused by climate change.

Image credit: BOB STENECK

And It Gets Even Worse: Desperation Does More Damage

With the increased level of effort needed to catch rapidly declining amounts of fish, subsistence fishers are getting desperate. Even though dynamite fishing is outlawed, it is an expedient way to feed one's family when there are no other options. Dynamite fishing does tremendous damage to reefs, that can take generations to recover from, and hastens the fish stock decline.

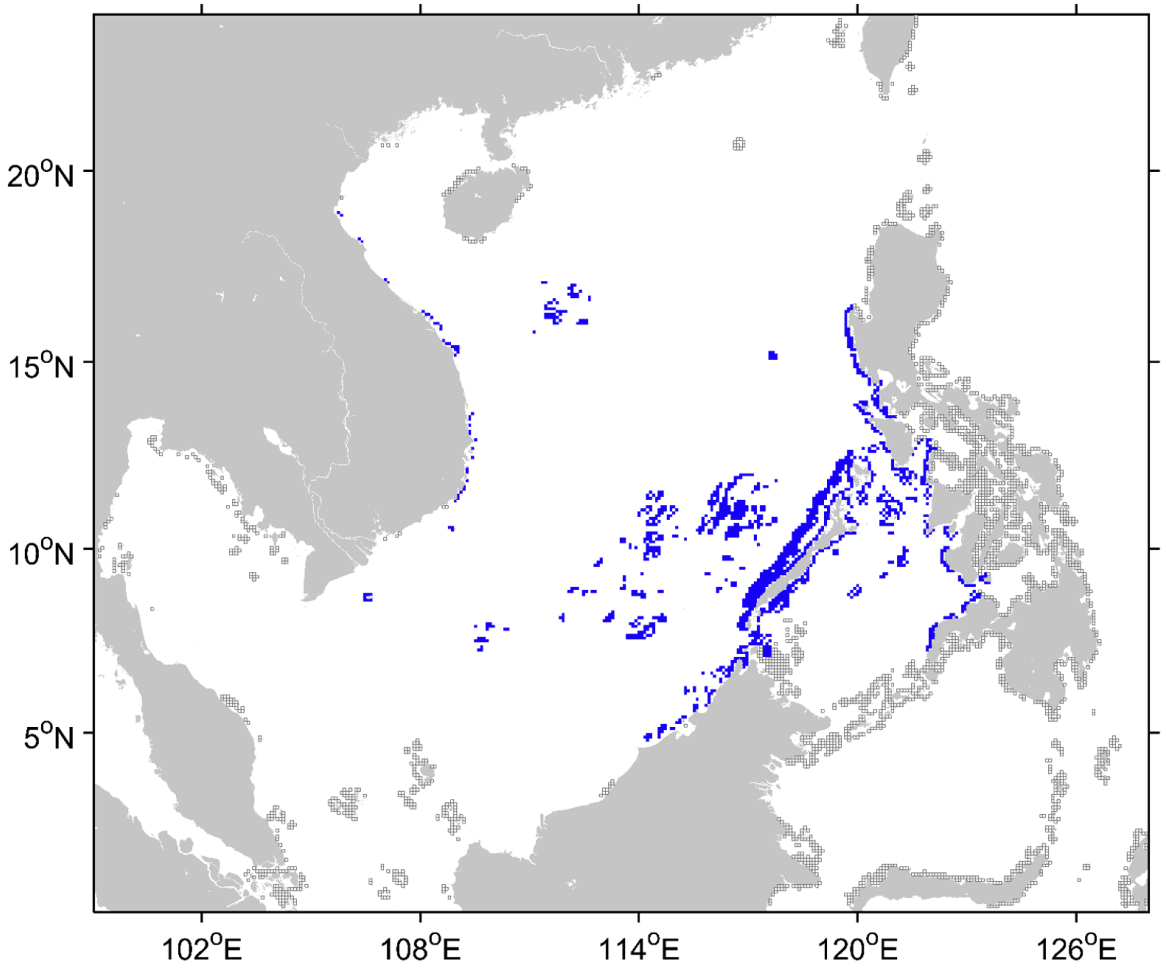
Image credit: Dynamite Fishermen Arrested in Carles, Iloilo – file photo – www.philippineslifestyle.com

Why Does The Health Of The Spratly Reefs Matter?

- Coral reef fishes supply a **major source of protein for about 85% of coastal inhabitants.**
- The **larvae** for the fish that inhabit the South China Sea come largely from its coral reefs. The larvae from the Spratly reefs get distributed around the South China Sea by the winter and summer monsoons.
- Many of the inhabitants of the reefs are **food for the fish** that make up the food supply for the nations that border the South China Sea and support commercial fisheries.
- The Spratly reefs function as a source of food for migratory fish, including tuna, that travel through the South China Sea on their way to the Indian Ocean.
- The **size of the fish stock** in the South China Sea is directly linked to the **health of its reefs**.

Image credit: Monga Bay

The Health Of The Spratly Reefs Impacts All Bordering Nations



These reefs (in blue) in the South China Sea are the "nurseries" that generate the larva that become the adult fish stock that make up the fisheries in Vietnam, The Philippines, Malaysia, Brunei, and Indonesia.

*"This emphasizes the value of **international partnerships** in coral reef management given how these areas share similar regional roles in supplying larvae to the region."*

Image Credit: Larval connectivity patterns of the North Indo-West Pacific coral reefs, Patrick R. Pata, Aletta T. Yñiguez

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In Summary

Human activity in the Spratly Islands is **damaging** the coral reefs that supply **food for millions** of people in the region.

1. The hundreds of ships that are anchored in the Spratlys are dumping raw sewage onto the reefs they are occupying. Verified by satellite imagery.
2. The excess nutrients in sewage are causing elevated concentrations of Chlorophyll-a, leading to a cascade of reef damage that can take **decades to recover** from **even with active mitigation**.
3. The damage to the reefs in **just the last 5 years** is visible from space. This time period is **after** and therefor in addition to the well-documented reef destruction wrought by China's giant clam harvesting and artificial island building.
4. Damaging these reefs directly affects the fish stocks of the entire South China Sea and can lead to a **hunger crisis** in coastal regions and a **collapse of commercial fishing** in the South China Sea. This is a catastrophe of epic proportions and we are close to the point of no return.

This Needs To Stop Immediately! **#ChinaStopShittingOnTheSpratlys**

On offshore atolls and archipelagos in the South China Sea, **coral cover** has declined an average of 67% within the past 10-15 years.

Total **fish stocks** in the South China Sea have have declined by 66% to 75% in 20 years.

Divers swimming with a turtle, Tubbataha Reefs Natural Park, Philippines | © RooM the Agency / Alamy Stock Photo

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Methods and Sources

Imagery: All imagery was provided by Sentienel 2 of the European Space Agency, freely available at the ESA's open access hub

Algorithm: The Chlorophyll-a Concentrations were determined using the C2RCC algorithm which is supplied with the European Space Agency's Sentinel Toolbox, SNAP, which is also freely available. Chlorophyll-a concentrations are in mg/m^3.

Sources:

1. OneSharedOcean
2. Nutrient pollution disrupts key ecosystem functions on coral reefs –The Royal Society Proceedings
3. Global assessment of the status of coral reef herbivorous fishes: evidence for fishing effects
4. Too much algae -- and too many microbes -- threaten coral reefs – National Science Foundation
5. Dissolved organic matter feedbacks in coral reef resilience – National Science Foundation
6. Assessment of Coral Reef Fish Stocks From the Nansha Islands, South China Sea, Using Length-Based Bayesian Biomass Estimation
7. The wicked problem of China's disappearing coral reefs, Hughes TP, Huang H, Young MA.
8. A Blueprint for Fisheries Management and Environmental Cooperation in the South China Sea, CSIS
9. Hysteresis in coral reefs under macroalgal toxicity and overfishing
10. Larval connectivity patterns of the North Indo-West Pacific coral reefs, Patrick R. Pata, Aletta T. Yñiguez
11. The rising environmental of China's offshore island grab, Yale School of the Environment

Simularity's AIADS Software

This anomaly heat map (red squares in the above image) was generated by AIADS. It is shown overlaid onto a European Space Agency Sentinel 2 image. After reviewing the imagery, our analyst then drew the pink polygons around the areas that need further investigation.

Please contact us at info@simularity.com to chat about your monitoring project.

Simularity is a software company that uses AI and Geospatial data to determine when significant changes have happened to an area. Our software, Automated Image Anomaly Detection System (AIADS), enables us to automate the scanning of large areas, such as the South China Sea, for unusual activity.

Our South China Sea monitoring project helps us demonstrate the value of our software. When new low-cloud Sentinel 2 images of the South China Sea are available, they are automatically downloaded and analyzed by Simularity's AIADS software.

A human analyst then reviews the results of the AIADS analysis, an "anomaly heat map" that highlights significant changes in red. By looking at the new image, the anomaly heat map, and historical images, our human analyst determines where there are changes that deserve a closer look. Those are indicated in this report with the red polygons.

Running AIADS on free Sentinel 2 imagery makes it possible for us to inexpensively monitor a very large area.

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