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Fighting Cartel-Enabled Illegal Fishing Using Remote Sensing

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BACKGROUND

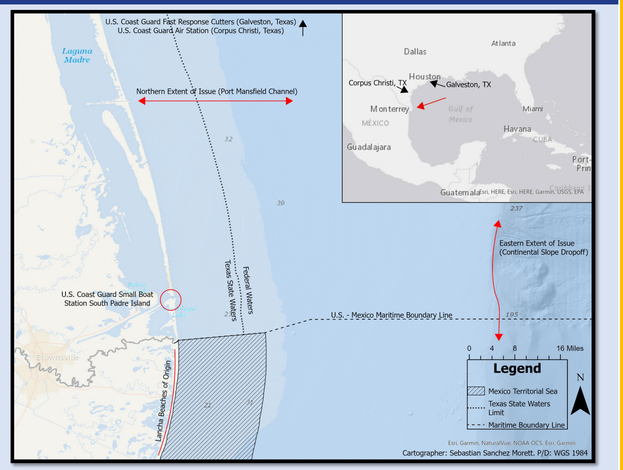

Figure 1: Study Site Map Including U.S. Coast Guard Law Enforcement & Jurisdiction

Illegal, Unreported, and Unregulated Fishing (IUUF) is a practice that is detrimental to maritime security, the environment, and legal fisheries. In the U.S., the red snapper, *Lutjanus campechanus*, fishery in the northwest Gulf of America is notably affected by IUUF (Figure 1). On a near-daily basis, Mexico based fishers enter the U.S. Exclusive Economic Zone off South Texas illegally. They come in small boats known as *lanchas* (Figure 2) to fish for red snapper indiscriminately using bottom long line gear (Figure 3). Figure 2 shows how the crew hauls in the line by hand. Bottom long line fishing is where extensive lengths of fishing line are anchored to the sea floor with baited hooks to target species at the bottom. Lancha operations are managed by the Gulf Cartel and are used for other transnational crime as well (Figure 4). State and federal law enforcement agencies are committed to deterring the *lanchas*, but the fishers evade federal prosecution through a loophole in U.S. legislation.

Figure 2: *Lancha* (U.S. Army, 2023)

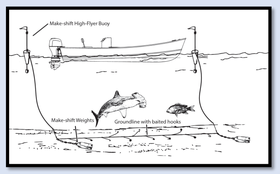

Figure 3: *Lancha* Fishing Gear (Sanchez, 2025)

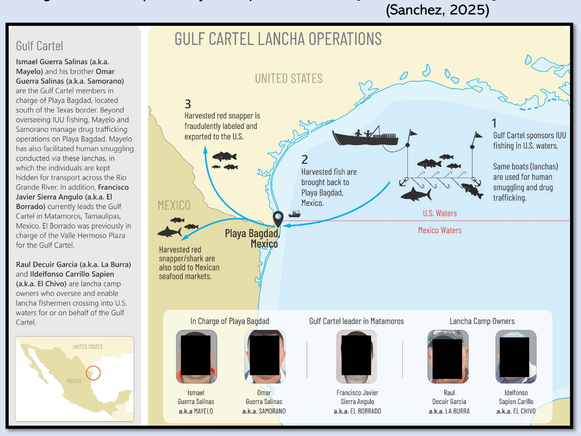

Figure 4: Gulf Cartel Lancha Operations Diagram (U.S. Treasury Department, 2024)

METHODS

QUALITATIVE

Cadets conducted summer field work learning about stakeholders, to include the Mexican Navy and U.S. Coast Guard operations in the Gulf of America, aboard the USCG Fast Response Cutter *DANIEL TARR* based out of Galveston, Texas, and aboard the Mexican Naval Academy Ship *Cuahtemoc*, and spent one additional week in South Texas conducting interviews with fishers, law enforcement, and researchers during the Fall 2024 semester.

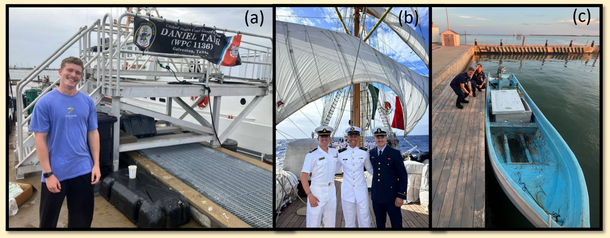

Figure 5: Qualitative Field Work. (a) Cadet Jaime Gustafson aboard USCGC *DANIEL TARR*. (b) Cadet Sebastian Sanchez aboard Mexican Training Vessel *Cuahtemoc*. (c) Cadets Gustafson & Sanchez at USCG Station South Padre Island with a *lancha* they helped interdict.

QUANTITATIVE

Remote sensing may support law enforcement in their detection of lanchas, especially when weather conditions limit patrol coverage. Synthetic Aperture Radar (SAR) is a type of imagery that uses radar pulses to create high resolution images not affected by weather conditions or time of day. Vessels may be detected from SAR imagery by their distinct radar backscatter. Using publicly available SAR imagery from European Space Agency's Copernicus Sentinel-1 Satellite, imagery taken of the study site was processed on geospatial software, ArcGIS Pro, to detect vessels with *lancha* characteristics in the area. Vessels legally broadcasting their location, from data provided by the U.S. Coast Guard Navigation Center, were removed from consideration to increase the likelihood of a detected vessel of being a *lancha*.

Purpose	Type	Source
Satellite Imagery	Synthetic Aperture Radar, 20x 22 meter Spatial Resolution, HH Polarization	European Space Agency Copernicus Sentinel-1 Satellite Imagery
Ship Broadcasting	Satellite Automated Information System (AIS)	U.S. Coast Guard Navigation Center

Table 1: Data sources for SAR/S-AIS Cross Reference Methodology

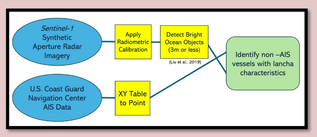

Figure 6: SAR/S-AIS Cross Reference Methodology flow chart to increase detection of *lanchas*

RESULTS

The results of the interview were used to construct a fishbone diagram (Figure 7), which takes qualitative data from the interview and analyzes the causes of the lancha IUUF issue. The head of the fish represents the issue being investigated, while the rest of the skeleton serves to elaborate on the individual factors driving the issue. This method of data analysis helped to congregate the data and identify key points of focus from the interviews.

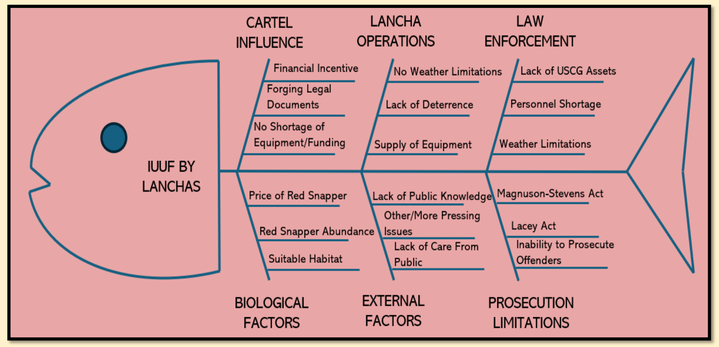

Figure 7: Fishbone diagram to identify the causes and effects of the *lancha* IUUF problem.

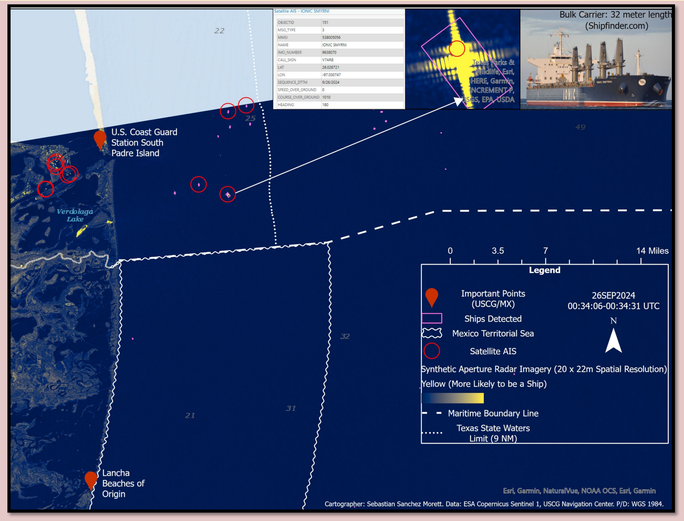

Figure 8: Results Map of AIS—Subtraction Method in Study Site

Postprocessing, the Synthetic Aperture Radar (SAR) imagery, as seen in Figure 8, revealed vessel backscatter at 20 meters resolution (yellow marks). Vessel backscatter automatically detected by the ArcGIS Pro tool Detect Bright Ocean Objects (pink rectangles). Ships transmitting Satellite AIS during the time frame the SAR imagery were captured (red circles). The random vessel candidate selected (transmitting S-AIS and automatically detected) revealed to be a bulk carrier style ship 32 meters in length. This suggests that the methodology used here is capable of accurately identifying larger vessels. Publicly available SAR imagery available in the study site area is not provided at a high enough resolution to detect vessels with lancha characteristics, as spatial resolution is limited to detections of vessels 20 meters or greater. To identify lanchas of around 6 meters in length, higher resolution SAR imagery would need to be obtained.

DISCUSSION

As shown in the fishbone diagram in Figure 7, we found that the main factors leading to IUUF by lanchas were limitations to law enforcement operations, the steady supply of equipment and funding to lancha crews by the Gulf Cartel, loopholes in U.S. legislation that limit prosecution power, and advantageous biological conditions for the red snapper to thrive in the area.

The results of the conducted interviews on law enforcement personnel, researchers, and fishers found the following:

- Law Enforcement agencies in South Texas work and collaborate closely daily for training purposes and joint operations.
- There needs to be an increase in USCG assets and personnel in the area to establish a stronger presence and deter IUUF activity.
- Although red snapper stocks have recovered from their historically low levels (NOAA, 2023), IUUF by *lanchas* undermines legal fisheries and conservation efforts by depleting available resources in the area for commercial and recreational fishers.

It should be noted that the Harte Research Institute selected interview participants from established prior relationships, which could introduce bias in the small interview sample.

CONCLUSION

Through quantitative and qualitative research, the study was able to communicate the complicated nature of the illegal red snapper fishery and propose a lancha detection tool to support law enforcement. The illegal red snapper fishery's direct ties with cartel organizations deem it a maritime security threat which also degrades legal fisheries and conservation efforts in the area. Law enforcement is limited in countering these illicit operations primarily due to understaffing and unsafe weather conditions. Remote sensing has been successfully used to detect vessels similar to lanchas, like the salmon fishing fleets off Alaska (Figure 9), and the fishing fleets near Ghana (Figure 10). Detection results in the study area are limited due to the resolution of the publicly sourced imagery available (20-meter resolution). Recommendations to law enforcement and future studies should explore the use of commercial SAR imagery, and unmanned aerial systems and aircraft equipped with SAR capabilities to gather sub 3 meter resolution SAR imagery to successfully be able to detect *lanchas*. In the long run, addressing or creating legislation that allows the federal prosecution of *lancha* crews would be the greatest deterrent of these activities as the majority of the crews are frequent repeat offenders.

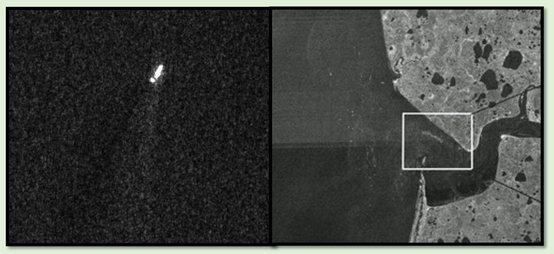

Figure 9: SAR Imagery Used to Identify Salmon Fishing Fleets in Alaska (NOAA, 2000)

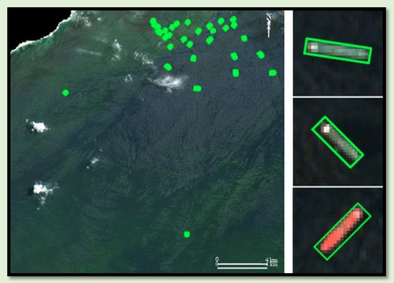

Figure 10: SAR Imagery Used to Identify Fishing Fleets in Ghana (Kurekin, 2019)

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