IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

ILLEGAL FISHING IDENTIFICATION IN OCEANS USING MODELLING OF GEOGRAPHICAL AREAS-A REVIEW

[1]Pankaj Kumar, [2]Ajay Kumar, [3]Nishant Nehra

[1]U.G. Student, [2]Assistant Professor, [3]U.G. Student

[1,2,3]Computer Science and Engineering,

[1,2,3]JSS Academy of Technical Education, Noida, India

Abstract: Illegal fishing is a pervasive and destructive global issue that poses a significant threat to maritime ecosystems and the resilience of fisheries. Illegal, unregulated, and unreported (IUU) fishing leads to extinction of fishing population. Also, fishing businesses facing a major financial problem throughout the globe due to IUU. The effective identification and monitoring of illegal fishing activities are crucial in order to protect maritime resources and the enforcement of international regulations. This review paper explores the use of geographical area modeling as a promising approach to combat illegal fishing in oceans. We discuss various techniques and technologies that have been employed to detect IUU fishing within specific geographical areas, providing insights into their strengths, weaknesses, and future prospects. We will develop machine learning algorithms to analyze the geospatial data and identify patterns associated with illegal fishing activities. The current study attempted to conduct a methodical and critical analysis of around Sixty (60) prior publications that were pertinent and published in academic journals throughout a twenty two-year period (2000 – 2022) in modelling of geographical areas to detect illegal fishing. Specifically :(i) Anomaly detection to identify irregular fishing behaviors, such as fishing in prohibited areas(ii) The application of machine learning techniques and how well they match this domain. (iii) the ideas and elements influencing modelling of geographical areas and the starting point of study, (iv) the pertinent mistake and accuracy metrics. Finally, we summarize the difficulties and prospects for more study in the identification of illicit

Index Terms **- Illegal fishing, unreported fishing, unregulated fishing, Geographical areas, Marine resources, Geographical Modelling**

I. INTRODUCTION

For Oceans provide food, livelihoods, and various ecosystem services. However, the oceans are facing a growing threat: illegal, unreported, and unregulated (IUU) fishing. This is the multifaceted issue. The task of managing marine resources sustainably and promoting conservation is very challenging. The extent of illegal fishing has increased significantly due to financial incentives and insufficient oversight and enforcement systems. Illegal fishing not only causes harm to the marine ecosystem [1] and diminishes fish stocks, but it also robs legitimate fishermen and coastal communities of their means of subsistence. For the sake of our oceans' long-term health, this problem must be resolved.

The problem of illicit fishing in oceans has been addressed in part in recent years by the fields of remote sensing and geographical modeling. Enforcement of laws can be efficiently carried out by identifying suspicious fishing operations and cross-referencing them with other environmental and geopolitical aspects through monitoring vessel movements and analysis of catch data.

The goal of this review paper is to present a thorough summary of the current in illegal fishing identification through the modelling of geographical areas. We will explore the key challenges associated with IUU fishing, the advancements in satellite-based technologies and geographical information systems (GIS), as well as the various modelling approaches used to detect and combat illegal fishing activities. We will also delve into case studies and real-world applications, illustrating the successful implementation of these technologies in different ocean regions.

We will consult a multitude of studies and knowledge as we set out on this multidisciplinary exploration of marine science, technology, and policy [2]. We wish to contribute to the ongoing efforts to protect the oceans for present and future generations by having a thorough understanding of the strategies and instruments available for monitoring illegal fishing and their consequences for ocean conservation. Many governments and international organizations have implemented stronger laws and surveillance techniques [3] in an effort to curb illegal fishing, which has intensified in recent years. Identifying and tracking illicit fishing activities through the use of data-driven methodologies and cutting-edge technology is one promising path in this ongoing war. To have a deeper comprehension of the promising strategy of "Illegal Fishing Identification in Oceans using Modelling of Geographical Areas," this review article explores the several technologies, approaches, and data sources that are advancing our capacity to stop IUU fishing and safeguard our oceans.Unlicensed fishing, taking prohibited species, going over catch quotas, fishing in restricted regions, and using unapproved equipment and techniques are all considered forms of illegal fishing. It is frequently motivated by financial gain and disdain for laws intended to preserve fisheries and safeguard the maritime environment. The consequences of illegal fishing are far-reaching, including:

- **Resource Depletion:** IUU fishing contributes to overfishing, depleting fish stocks and jeopardizing the long-term sustainability of fisheries. This threatens the food security of coastal communities and the global population.
- **Environmental Damage:** Unregulated fishing practices can harm marine ecosystems, such as by catch [4] of non-target species, damage to coral reefs, and pollution from illegal fishing vessels.
- **Economic Loss:** Legal fishers and coastal communities suffer economic losses as they have to compete with illegal operators who often undercut prices due to their lack of adherence to regulations.
- **Security Concerns:** IUU fishing is sometimes associated with transnational criminal organizations, as well as human trafficking and drug smuggling, making it a security concern for coastal states and the international community.

To address these issues, effective detection and enforcement measures are essential. These include satellite technology, electronic monitoring systems, patrolling by coast guards and navies, international agreements and regulations, and public awareness campaigns.

In this paper, we will explore the current state of illegal fishing, its environmental and socio-economic impacts, and the regulatory measures in place to address it. We will then delve into the innovative approaches that leverage geographical modelling techniques, remote sensing data, machine learning, and other advanced technologies to identify and combat illegal fishing activities. By examining the potential and challenges of these techniques, we aim to provide a comprehensive overview of the advancements in this field, as well as insights into the way forward in preserving the delicate balance of our ocean ecosystems and ensuring the sustainable management of our marine resources. The main objectives of the previous studies discussed in this review paper are as follows:

II. OBJECTIVES OF DIFFERENT STUDIES

- To acquire a more accurate image of how catches affect sustainability, a process known as "re-construction of catches" [7][8][9] is employed".Since these investigations look at total withdrawals at a variety of different regional levels, they frequently place a heavy emphasis on "unreported" catches—although, as previously stated, only a small portion of them is probably IUU. The quantity of the unrecorded or incorrectly reported capture is more important to these researches than the reason it occurred.
- To draw attention to a specific species and simply to increase awareness of IUU capture levels, and this can enable the application of certain techniques suitable for those kinds"[10].
- The desire to utilize the estimates to identify appropriate management actions to prevent IUU fishing is a key motivator for estimating levels of IUU catch"[11].

III. MATERIALS & METHODS

3.1 Data Collection:

In order to complete the study of studies, pertinent studies were gathered using the following methods: (i) searching the literature for pertinent papers published in scientific journals after undergoing people review; (ii) searching the web for project reports and other pertinent studies; and (iii) requesting pertinent studies from RFMOs through the FAO as well as (iv) the consultants' attendance at the Fifth (GFETW)

Sixty (60) cutting-edge research papers that have been published in journals, conferences, magazines, and student theses that are pertinent were found online using search phrases related to the current study's emphasis. like detection of illegal fishing, and sustainability of marine ecosystem. All downloaded books were then thoroughly examined and divided into two categories for the purpose of identifying illegal fishing one is manual and other is machine learning techniques.

3.2 Data Screening and analysis:

Forty-four of the studies were genuinely calculating IUU fish catch amounts. After that, the synthesis files for the 44 pertinent researches were examined to identify the most important discoveries, results, and suggestions.

3.3 Findings:

The review of studies revealed that the geographical scope of studies estimating IUU catches varied, comprising studies that are mainly neighborhood in scope to those that are national and metropolitan in scope to those that attempt to figure out the IUU catch on a global scale. Regarding several studies that provide global estimates, these typically have particularly large levels of ambiguity surrounding the estimations produced because, as these research' sizes increase, the assumptions they must make for elements for which there are no data cause them to either lose granularity or accuracy.

There are significant levels of ambiguity surrounding the estimations produced because, as these studies get larger, observational data, shipboard surveillance footage, inventory evaluation algorithms, commercial data, expert judgment based on experience, logbooks, remote sensing (e.g., VMS, AIS), surveillance data and compliance levels, and expert judgment based on experience are just a few of the many different information sources used in the studies. Various approaches are employed to produce estimates of various elements of IUU fishing activities, and these information sources serve distinct purposes in this regard. According to Tsamenyi et al. (2015)[5] because of the variety of national laws, legal frameworks governing international fishing activities, and RFMO conservation and administration efforts, there are many ambiguities and instances where the three elements of illicit underwater fishing overlap.

There is presently no guidance on how to do IUU risk assessments, as noted by the 5th GFTEW. Creating an inventory and reviewing all currently in use risk assessment frameworks would be the first step in creating such technical recommendations. There are overlapping definitions for several research Calculations of the undisclosed captures made by ships operating under valid licenses but failing to comply with monitoring regulations, for instance, primarily fall under FAO[6] IUU definition. However the neglected captures were achieved in compliance with or against existing technological standards is not indicated by these estimations. (such as prohibited periods, restricted locations, and equipment specs).

IV. LITERATURE REVIEW

This review of the literature describes how some of the methods related to this research paper have been implemented over the last decade. The literature survey of different approaches with their advantages and disadvantages is given in Table 1.

Table 1: Comparison of various approaches

Name of the Author	Year	Title	Technique used	Advantages	Disadvantages
Marza Ihsan Marzuki, Philippe Gaspar, Rene Garello, Vincent Kerbaol, and Ronan Fablet	2017	Fishing Gear Identification From Vessel-Monitoring-System-Based Fishing Vessel Trajectories	RF and SVM	Recognition performance is greater than 97%	Complex project due to use of complex algorithms
Sufian Almubarak	2020	Illegal fishing and its impacts on marine life	Electronic Reporting using Cameras	Comprehensive, containing statistics from different geographical areas,	Problems can arise due to natural factors, such as climate change
Abhishek Kumar, P. Sindhu, Ankit Kumar, R. Priya, L. Dheepanbalaji, T. S. Shanthi, and V. D. Ambeth Kumar	2022	Illegal fishing and the recognition of odd ship activity by the automated recognition system	Global Positioning System satellite	track ship movements in the seas.	Not able to get full view of illegal act of fishing
Agus Prayudi, Zaqiatud Darojah, Anhar Risnumawan, and Indra Adji Sulistijono	2020	Computer Vision-Based detection System for Preventing Illegal Fishing on UAV Images	Drone Technology	surveillance and investigation process is easier	Not able to cover all the areas and problems may arise due to climatic changes
COLHO Manuel Pacheco, FILIPE, (P) FerreIRA José António Candeias Bonito,(P), Alberto Manuel M.	2008	Illegal fishing: an economic analysis	Theory of “Crime and Punishment” of Becker	There is a significant attempt to precisely outline the legal processes for charging the offenders.	Stricter sanctions are not the first line of defense for stopping illicit fishing.
V.K.G Kalaiselvi, Pushgara Rani D., and J.Ranjani	2022	Illegal fishing detection using neural network	Neural Network	Relative position of fishing sites could be identified	Large amount of data is required
Gohar A.Petrossian	2015	A situational approach to remove illicit, unreported, and unregulated (IUU) fishing.	Situational Approach	Illegal fishing level can be detected as per data	Don’t specify any real method but only based on situations To detect the illegal fishing.

Aanes, S et. al. [12] presented a case study on total retained catches of certain species. It focuses on using AIS and VMS presence data to compute anchor points (average weight of fishery products on board each journey as a capacity-related function represented in GRT) and extrapolate to the entire fleet based on data from thoroughly examined vessels. Official registries provide information on vessel sizes, and the calculated conversion factors are used to determine the fish storage capacity based Logistic slopes show considerably different when a linear regression evaluation of information for each kind of ship and location uses the amount of fish as the variable that depends and storage space as the independent factor. This method's Its dependence on expectations on the presentation of catches at sea (whole, H&G, or fillets) is a shortcoming that might significantly affect forecasts..on the gross registered tonnage of the vessel.

Agnew, D.J. et. al. [13] presented a case study on detection of illicit and unreported tooth fish captures. This research focuses on Commercial Longlining and gillnetting. This study illustrates the various forms of illicit, unreported, and unregulated (IUU) activities, including Economic catches, catch-and-release and unintentional deaths by others, as well as unlawful activities of non-party-registered ships controlled by individuals**.** Main methodology used in this study is IUU amount is calculated as the trip length, expected and The study demonstrates that the CCAMLR program offers tools for monitoring toothfish trading and keeping illegally harvested fish out of the main toothfish markets. The conservation measure and the explanatory memorandum permit refusal in the event that a document is missing or its validity is doubted, as well as the holding of a cargo while paperwork is checked.

It concludes that CCAMLR Catch Documentation Scheme is distinctive in that it was created and approved by an international intergovernmental organization whose goal is to conserve fish stocks that occur within its purview, but which also affects the harvesting of the species in areas that fall outside of its purview, number of active vessels, and capture rates by fishing area.

Agnew, D.J., Pearce, J., Pramod, G., et al.[14] proposed a study which uses data with enough clarity to identify local variations in the amount and pattern of illicit fishing during the last 20 years, and it is able to demonstrate a strong relationship between governance and the amount of unlawful fishing. The authors' research was restricted to unreported catches (IU), or illegal and retained captures that are often left unreported and taken in high seas waters under the control of a (RFMO).

The compliance hypothesis is the foundation of this report. estimation of likely IUU vessel activity (days fishing) based on modelled encounter likelihood, known patrol vessel activity, known catches made by lawful vessels, and observations of IUU vessels and gear. Ball (2005) presented a variation that attempted to solve the zero-observation problem, but it was unable to be parameterized. This model is less accurate where zero sightings are made.

Ainsworth, C.H. et. al. [15] proposed a research work in order for biologists to fully understand the fishing's negative impact on the maritime environment they should obtain an estimate of the total amount of resources drawn from the ecosystem. Together with nominal fisheries landings and reported discards, which are regulated and monitored, a certain amount catch (IUU) will be eliminated.

The authors provide an approach based on independent estimates of misreporting Using past fishery effects to calculate the total IUU captures throughout the years. A Monte Carlo-style approach was used to determine unaccounted catch for the groundwater fish and chinook fisheries in British Columbia, as well as a related uncertainty range. According to the study, discards were roughly 2.2% until the middle of the 1980s, when they started to decline and are now less than 1%. Not only would significant political shifts in the fishing sector have contributed to this decline, but technical advancements in salmon fishing methods also played a role in the 1980s.

Ball, I. et. al.[3] proposed a research work in which it may be feasible to determine a precautionary assessment of illegal fishing with a certain level of confidence (e.g., 80%) such that the actual number of illegal fishing days is fewer than or equal to the precautionary estimate.

The authors proposes that the new method's results are comparable to those of the Agnew and Kirkwood (2005) method, indicating that the present approach is sufficient when there is little evasion and when it is well-established that zero observations correspond to zero illegal fishing. The new approach works better when there are no detections and may be able to handle instances where illicit conduct evades detection.

Al-Abdulrazzak, D. et. al[16] presented a study that catches frequently lead to noticeably altered baselines for past catches, casting doubt on the degree to which publicly reported numbers accurately reflect reality and the long-term viability of particular management choices. Here, authors "reconstruct" the missing sectors' contributions for every Gulf-adjacent country between 1950 and 2010. Since the 1950s, the Gulf countries have largely disclosed the amount of fish they take for artisanal and industrial purposes while significantly underreporting the amount of fish they collect for sustenance, recreation, and illegal fishing. It demonstrate that after compiling and comparing data from national agencies with FAO data, no discrepancies were discovered.

Belhabib, D. et. al.[17] This report is based on depletion of marine ecosystem due to over fishing. The case of Senegal fisheries research propose that in contrast to 80% two decades before, official data indicates that artisanal fisheries accounted for 50% of all extractions. Yet, artisanal harvests from Senegalese seas declined despite an increase in effort, indicating over-capacity, whereas catches by migrant fishermen expanded significantly. Whether transshipped, otherwise taken out of Senegalese seas, or dumped, IUU catches, which were valued at over $300 million US yearly, constitute a significant loss to Senegal. Furthermore, Senegalese artisanal fishermen's migrations are heavily impacted by the foreign fleet's illicit exploitation of the country's fisheries resources. As a result, these fishermen migrate more often to satisfy their fish needs in the face of rapidly depleting resources.

Author concluded that in the lack of an appropriate monitoring plan, the advantages that would have resulted from reducing foreign access to fisheries resources through the declaration of the EEZ and lowering foreign industrial fishing activity have remained elusive. Considering the strain that the industrial subsector generates.

Bremner, G. et. al. [18] presented a paper in which Objective of the study is to make estimation of unreported by catches in a NZ hoki fishery.It compares the logbook catch and effort statements of unseen vessels Using the spotted boats' paperwork entries using tow-by-tow data that is accessible. Authors proposed that Individual transferable quotas (ITQs) are a recognized management tool for fisheries, but they may also enhance the incentive to discard fish. Predicting the catches of unseen vessels was done using trawl data from trawlers in the New Zealand hoki fishery that were observed by the government. These forecasts were contrasted with the reported captures made by unseen boats. The reported catches from unobserved vessels differed markedly from those from seen vessels. The hoki fishery has blatant indications of misreporting. Inaccurate reporting jeopardizes the integrity of ITQ systems, robs stakeholders of rents, and skews catch statistics. The problem cannot be safely disregarded if reporting bias is the same in other fisheries. It is only applicable in situations with extensive fishing activities, a sufficient number of observers, and an effective enforcement mechanism that guarantees the inspection of every vessel and the registration of important details on the features of the gear and vessels.

Cisneros-M. et. al, [19] suggested that Mexico's fisheries have traditionally been marked by frequent changes in goals and management plans, which is indicative of the country's overall political structure.

Unfortunately, a lack of control over fishery overall and catch surveillance specifically has resulted in highly unclear fishing statistics, many of which are of low enough quality to be of any value in quantitative judgments based on reality.

When it is agreed that the catch in legal data is partial but the amount of the hidden catch is unclear, the reconstruction strategy employed in this study is that a well-informed estimate should be used in place of a zero figure.

Clarke, S.C., et. al. [20] used a Bayesian statistical model, the authors of this study calculate the quantity triggered in and exchanged inside public markets as two separate estimations of the actual Russian sockeye catch. To determine the "excess" catch arising from IUU fishing operations, these trade-based estimates of capture are compared with Governmental data on Russian fisheries. The results support the hypothesis (posterior probability 0.72 to >0.99) that substantial quantities of surplus Russian sockeye catch are being shipped to East Asian markets. The report's methodology, which forecasts catches from Russian seas, is based on business data from China, Korea, and Japan's The eastern bank Asian markets. This external market-based strategy is essential since it is likely that IUU fishing commodities will no longer be included in official Russian catch figures. It is also possible that fish, such as salmon, that are transhipped at sea will not be included in Russian customs paperwork.

Clarke, S.C., et al. [21] Combined genetic identification with trade data, Authors proposed Bayesian statistical methods to estimate the yearly quantity of globally traded shark fins by species. Shark fins are the most economically valued commodity from a group of species that are frequently not included in harvest statistics. This paper provides the first fishery-independent estimate of the amount of shark captures globally and concludes that shark biomass in the fin trade is three to four times bigger than shark catch numbers provided in the only global data repository. When their estimations are compared to estimated stock assessment reference points for the blue shark, one of the most traded species, it seems that current trading volumes in shark populations are either near or over the maximum sustainable yield levels.

“Free, C.M. et. al. [22] used a mixed-method approach to evaluate the extent, type, and causes of illegal gillnet fishing in Lake Hovsgol National Park, Mongolia, as well as its consequences on the fish populations in the lake, especially those of the endangered endemic Hovsgol grayling (Thymallus nigrescens). Surveys on abandoned fishing gear indicate that gillnet fishing is widespread and is increasing, with most fishermen using gillnet with a mesh size of 1-4 cm.Conversations with forest guards and local shepherds indicate that many people fish for food during the migration of april grayling for laying, and that some individuals fish year-round for a living.

Surveys of lost fishing gear and gear fragments are employed as data sources, which obliquely demonstrate ongoing illicit fishing. Among the Studies of missing boats and equipment parts are employed as sources of information, and they offer as oblique proof of ongoing illegal fishing. Interviews with rangers and herder households in order to determine the causes showed a recurrent interest in spring spawning migratory fishing.Losses in larger fish, such roach, burbot, and perch, were observed when trends in CPUE and fish mean length were examined; however, there was no impact on the target species, graylings.

Funge-Smith, S. et. al. [23] suggested that the initiative will improve nations' ability to pinpoint important problems and create and carry out strategies to deal with IUU fishing on a regional and sub-regional scale. The examination of current regional structures and the identification of gaps and priorities for regional initiatives will be facilitated for counties and their regional partners.

The important event to conduct a stocktaking analysis of the existing status will be the project inception and planning meeting. Nations and allies will get ready and bring updates to the conference. In order to address IUU, the meeting will provide a platform for regional partners and active initiatives to present their objectives and priorities. This summit will serve as the APFIC nations' first chance to expand on the 2009 and 2004 regional consultations with the FAO.

Glazer, S. et. al. [24] presented a report to update estimates of fishing in Somali waters by assessing the sustainability of commercial fish stocks in both local and global fishing communities.Authors use information from the media, public records, surveys of Somali fishermen, and satellite monitoring of fishing vessels to give updated and unique estimates of foreign fishing in Somali seas. They also project how much money Somalia would make by granting licenses to foreign ships that are aiming for HMS within its territorial seas. The quantity of fish that might be collected in Somali seas at sustainable levels is calculated, and the present levels of catch—both local and foreign—are compared to that amount. They also categorize the vital fish populations in Somali seas in terms of sustainability.

Green, T.J. et. al [25] presented a study to optimize the effectiveness and efficiency of the whole regulatory scheme. Data will be gathered to evaluate the level of enforcement and regulation across the board in Western Australia's input- and output-controlled fisheries. The second goal is to create national standards for the gathering and reporting of enforcement activity levels and compliance rates that are specific to each fishery, working with representatives from national fisheries regulatory groups.In order to allocate enforcement and educational resources more effectively across the Western Australian fishing industry, the authors suggested holding a national workshop to address issues that are common to all State compliance programs, develop common compliance measures that could be adopted nationally, and create precise compliance thresholds for each industry.

V. METHODOLOGY USED

5.1 Estimation of quantity of unknown catch:

It is well known that the anticipated catch per fisher, vessel, or gear unit matches the amount caught legally in areas, with comparable gear, targets, and areas; it may also include bycatch rates of ETP species. Another option for estimations is to use the number of probable trips, storage size and the boats' levels of capture —all based on legitimate vessels. If there are no legitimate ships management in the region, estimates can still be made using expert detection or knowledge of the specific features of the creature. Estimation can be done using data acquired from surveillance overflight (MRAG,2016), identification of specific vessels (Coalition of Legal Toothfish Operators, (2015)).

5.2 Unknown catch from known vessels:

The projected quantity of unreported or discarded catch for each fishing vessel involved in unlawful activity multiplied by the approximated number of ships participating in the activity yields the IUU. Observer data and comparison analysis of trips that were observed and those that weren't (typically using advanced statistical modelling techniques, such as Hentati Sundberg et al. [26][27][28][29][30] in cases where inexplicable differences can be linked to the use of illicit practices (such as illegal shark fining or illegal discarding)

5.3 Illegal fishing that does not yield unreported results:

Remote sensing and MCS techniques are the only trustworthy sources of information regarding the volume and kind of IUU fishing that does not result in unidentified catches. For instance, the use of camera technology to track all vessel movements (fish hauling, size and species, placing FADs) is becoming more and more popular in the tuna fisheries, and many businesses are now offering these services [31][32][33][34][35]

VI. COMPARISON OF DIFFERENT APPROACHES

The comparison of some common approaches is given in Table 2.

Table 2: Comparison of various approaches

Data type/source	Potential elements being estimated	Strengths	Weaknesses
Survey by satellite and on board camera	Estimates number of unauthorised vessels in prohibited areas.	High quality statistical data.	Computationally and electronically intensive/expensive
Stock assessments	Total undocumented captures of prey fish estimated	Suitable for every species.	Insufficient data on IUU fishing's incidental harm to nontarget organisms or ecological systems
MCS inspection data	Recording of individual violations	High resolution data.	Some activity may not be recorded by inspectors.
Expert judgement	Trends of fishing over time	Incorporates information from experts, usually MCS specialists or fishermen having firsthand knowledge of IUU activity.	May suffer from over-sampling

VII. FUTURE CHALLENGES

- Global estimate of IUU catch should be updated.
- Technical guidelines should be developed to improve quality of studies.
- IUU risk-based assessments should be promoted.

VIII. CONCLUSION

Detection of IUU fishing is necessary to improve our fishing resources around the world and secure the health of our oceans. Now latest technology is used to monitor the vessel's real time locations, their course, speed, latitude, longitude and records every detail of the vessel which enters the oceans. By the use of our project, we can model the geographical sites as legal or illegal hence protect the unreported fishing and can find illegal fishing vessels. We can reduce physical monitoring and can detect fishing in restricted region in very less time. Law enforcement team does not need to visit every fishing site for investigation. We can also detect illegal fishing in those parts of the oceans where physical monitoring is not possible.

REFERENCES

[1] Zeller, D., & Pauly, D. (2005). Good progress, but more to do: A review of the state of global marine fisheries. Marine Policy, 33(6), 835-842.
[2] Maxwell, S. M., et al. (2019). Defining real-time management of the ocean. Marine Policy, 105, 52-60.
[3] Ball, I. (2005) An alternative method for estimating the level of IUU fishing using simulated scaling methods on detected effort. CCAMLR Science 12, 143–161. (see fiche for Agnew and Kirkwood 2005) https://www.fao.org/3/bl765e/bl765e.pdf
[4] Agnew, D.J. (2000) The illegal and unregulated fishery for toothfish in the Southern Ocean, and the CCAMLR catch documentation scheme. Marine Policy 24, 361-374.
[5] Tsamenyi, M., Kuemlangan, B., Camillieri, M. (2015). Defining Illegal, Unreported and Unregulated (IUU) Fishing. FAO Expert Workshop to estimate the magnitude of Illegal, Unreported and Unregulated fishing globally, Rome 2-4 February 2015 https://ebcd.org/wpcontent/uploads/2014/11/577Report_of_the_FAO_workshop_on_IUU-2015-FEG.pdf.
[6] FAO. (2018). Meeting the sustainable development goals. Food and Agriculture Organization of the United Nations. https://www.fao.org/documents/card/en?details=I9540EN
[7] Ainsworth, C.H., Pitcher, T.J. (2005) Estimating illegal, unreported and unregulated catch in British Columbia's marine fisheries. Fisheries Research 75, 40-55.
[8] Swartz, W., Ishimura, G. (2014) Baseline assessment of total fisheries-related biomass removal from Japan's Exclusive Economic Zones: 1950-2010. Fisheries Science 80, 643-651.
[9] Pauly, D., Zeller, D. editors. (2015). Catch Reconstruction: concepts, methods and data sources. Online Publication.
[10] Bremner, G., Johnstone, P., Bateson, T., Clarke, P. (2009) Unreported bycatch in the New Zealand West Coast South Island hoki fishery. Marine Policy 33, 504-512. doi:10.1016/j.marpol.2008.11.006
[11] MRAG (2016) Towards the quantification of Illegal, Unreported And Unregulated (IUU) Fishing in the Pacific Islands Region. A report prepared for the Pacific Island Forum Fisheries Agency (FFA) https://www.sprep.org/sites/default/files/documents/publications/towards-quantification-illegal-fishing-pacific-region.pdf
[12] Aanes, S., Nedreaas, K., Ulvatn, S. (2011) Estimation of total retained catch based on frequency of fishing trips, inspections at sea, transhipment, and VMS data. ICES Journal of Marine Science: Journal du Conseil 68, 1598-1605.
[13] Agnew, D.J. (2000) The illegal and unregulated fishery for toothfish in the Southern Ocean, and the CCAMLR catch documentation scheme. Marine Policy 24, 361-374.
[14] Agnew, D.J., Pearce, J., Pramod, G., et al. (2009) Estimating the Worldwide Extent of Illegal Fishing. PLoS ONE 4, e4570.

[15] Ainsworth, C.H., Pitcher, T.J. (2005) Estimating illegal, unreported and unregulated catch in British Columbia's marine fisheries. Fisheries Research 75, 40-55.
[16] Al-Abdulrazzak, D., Zeller, D., Belhabib, D., Tesfamichael, D., Pauly, D. (2015) Total marine fisheries catches in the Persian/Arabian Gulf from 1950 to 2010. Regional Studies in Marine Science 2, 28-34.
[17] Belhabib, D., Koutob, V., Sall, A., Lam, V.W.Y., Pauly, D. (2014) Fisheries catch misreporting and its implications: The case of Senegal. Fisheries Research 151, 1-11. https://doi.org/10.1016/j.fishres.2013.12.006
[18] Bremner, G., Johnstone, P., Bateson, T., Clarke, P. (2009) Unreported bycatch in the New Zealand West Coast South Island hoki fishery. Marine Policy 33, 504-512.
[19] Cisneros-Montemayor, A.M., Cisneros-Mata, M.A., Harper, S., Pauly, D. (2013) Extent and implications of IUU catch in Mexico's marine fisheries. Marine Policy 39, 283-288.
[20] Clarke, S.C., McAllister, M.K., Kirkpatrick, R.C. (2009) Estimating legal and illegal catches of Russian sockeye salmon from trade and market data. ICES Journal of Marine Science: Journal du Conseil 66, 532-545. https://doi.org/10.1093/icesjms/fsp017
[21] Clarke, S.C., McAllister, M.K., Milner-Gulland, E.J., et al. (2006) Global estimates of shark catches using trade records from commercial markets. Ecology Letters 9, 1115-1126.
[22] Free, C.M., Jensen, O.P., Mendsaikhan, B. (2015) A Mixed-Method Approach for Quantifying Illegal Fishing and Its Impact on an Endangered Fish Species. PLoS ONE 10, e0143960.
[23] Funge-Smith, S., Lee, R., and Leete, M., (2015). Asia-Pacific Fishery Commission. Regional review of Illegal, Unreported, and Unregulated (IUU) fishing by foreign vessels. RAP Publication 2015/09 https://www.fao.org/3/ca4509en/ca4509en.pdf
[24] Glazer, S., Roberts, P., Mazurek, R., Hurlburt, K., and Kane-Hartnett, L., 2015. Securing Somali Fisheries. Secure Fisheries report.
[25] Green, T.J., and McKinlay, J.P., 2009. Compliance program evaluation and optimisation in commercial and recreational Western Australian fisheries. Fisheries Research and Development Corporation Final Report, Project 2001/069:, 77 pp
[26] Hentati-Sundberg, J., Hjelm, J., Österblom, H. (2014) Does fisheries management incentivize non-compliance? Estimated misreporting in the Swedish Baltic Sea pelagic fishery based on commercial fishing effort. ICES Journal of Marine Science: Journal du Conseil 71, 1846-1853.
[27] Worm, B., et al. (2009). Rebuilding global fisheries. Science, 325(5940), 578-585. doi:10.1126/science.1173146
[28] Teh, L. S. L., & Sumaila, U. R. (2011). Contribution of marine fisheries to worldwide employment. Fish and Fisheries, 12(2), 144-162.
[29] Sumaila, U. R., et al. (2015). A bottom-up re-estimation of global fisheries subsidies. Journal of Bioeconomics, 17(3), 201-225.
[30] Cisneros-Montemayor, A. M., et al. (2016). Potential use of big data in global fisheries. PLoS ONE, 11(11), e0163057.
[31] Kroodsma, D. A., et al. (2018). Tracking the global footprint of fisheries. Science, 359(6378), 904-908.
[32]Queiroz, N., et al. (2016). Ocean-wide tracking of pelagic sharks, 113(6), 1582-1587. https://doi.org/10.1073/pnas.151009011
[33] Hazen, E. L., et al. (2018). ocean management tool to reduce bycatch. Science Advances, 4(5), eaar3001.
[34] Whitten, L. B., et al. (2018). Machine learning approaches to predict distribution and abundance of marine species. Ecological Informatics, 46, 15-21.
[35] Valls, A., et al. (2017). Machine learning to model the spatial distribution of fish: A case study in the NW Mediterranean Sea. Ecological Informatics, 39, 10-18.