Pilot 21: **Underwater cultural heritage of Israel**

E. Galili, D. Edelist, W. Hamdan, I. Ogloblin Ramirez

ILIAD Marketplace: On line description of the pilots https://ocean-twin.eu/marketplace

The University of Haifa is engaged in the ILIAD project in the following fields:

1) Jellyfish Forecast-Dor Edlist, Dror Angel
2) Bio diversity- Anna Brook, Haitham Ezzy
3) Oil spill- Anna Brook, Tom Avikasis Cohen
4) Cultural heritage- Ehud Galili, Wassim Hamdan, Dori Edelist, Isaac Ogloblin

Architecture

Pilot 21 Underwater cultural heritage, Israel – University of Haifa

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Digital Twin Data Acquisition/Collection → **Digital Twin Representation** → **Hybrid/ Cognitive Digital Twin Generation** → **Digital Twin Visualisation and Control**

Sources of data collected

- *The public (Citizen science): recreational divers, commercial and navy divers, fishermen.
- *Archaeological excavations and surveys.
- *Archives: Israel Antiquities authority, Universities, Underwater Exploration Society.
- *Scientific literature: publications, survey diving reports, excavations reports.

OIM (Ocean information model) Preprocessing and storage (PSNC)

*Processing and sorting the collected data.

*Arranging the sites in 9 survey maps covering the Israeli coast.

*Establishing a typology of archaeological assemblages according to their nature.

*Preparing an interactive GIS platform for all sites (Wassim Hamdan).

*Establishing the digital database – based on points (small sites) and polygons (large sites).
*Sorting the sites according to chronological, geographical and cultural settings (e.g., location, period, type of site, water depth, type of sea-bottom).
*Assessing the scientific value, accessibility and attractiveness of sites (e.g., importance, risks, relevant publications).

End users and products
*Government planning authorities
*Government nature reserve and antiquities authorities
*Archaeologists and historians
*Local municipal authorities

*9 high resolution GIS maps of sites (points and polygons)
*Excell database table with observations and links to references
*Marketplace with links to initial products https://ocean-twin.eu/marketplace
*Scientific and popular publications and public engagement

Sensor data | Data Lake / Data Space / Infrastructure | DT Core | DT Visualization

Data Acquisition/Collection → **Data Storage/ Preparation** → **Analytics/AI/ Machine Learning** → **Action/Interaction/ Visualization/Access**

ocean_twin

Introduction

Many important events in the history of humanity took place along the east Mediterranean coast.

The Neolithic revolution, the emergence of the three monotheistic religions, and the rise and fall of many empires and cultures which dominated the region, and have left archaeological traces on land and at sea.

A whole chapter of the history of the Land of Israel is hidden underwater.

Data acquisition

Over the last six decades, underwater excavations and surveys have been carried out by archaeologists along the Mediterranean coast of Israel. In addition, numerous finds were reported by citizen divers.

These activities have revealed a variety of underwater cultural resources that can be divided into 4 categories: A) submerged prehistoric settlements, B) the remains of shipwrecks and cargos, C) harbors and anchorages, D) various marine associated coastal installations.

In recent decades, contemporary metal-made shipwrecks, aircrafts, and submarines have been added to category B of the studied cultural resources.

The Problem

Much of the valuable information that has been gathered has been published in scientific journals and popular publications, while a significant part has yet to be studied, recorded and published.

Much of the archaeological information is scattered in various places (institutions, archives and individuals) and is unavailable to researchers, planners and the general public. Often the data is available in un-accessible hand-written diving reports, reflecting different recording styles and methodologies.

Thus, the information has to be gathered, processed, standardized and written in a proper database, that will enable further research, publication and proper planning and management of the heritage.

The solution

In order to preserve and manage the remains of ancient civilizations along the Israeli coast and provide essential information to institutions, scientists, government authorities and private planning bodies, a reliable data base of sites is needed.

In the current ILIAD project, the available data regarding the underwater sites off the Mediterranean coast of Israel, as well as selective coastal sites, has been compiled and gathered in a digital database, including a detailed GIS mapping of nine survey maps covering the Mediterranean coast of Israel.

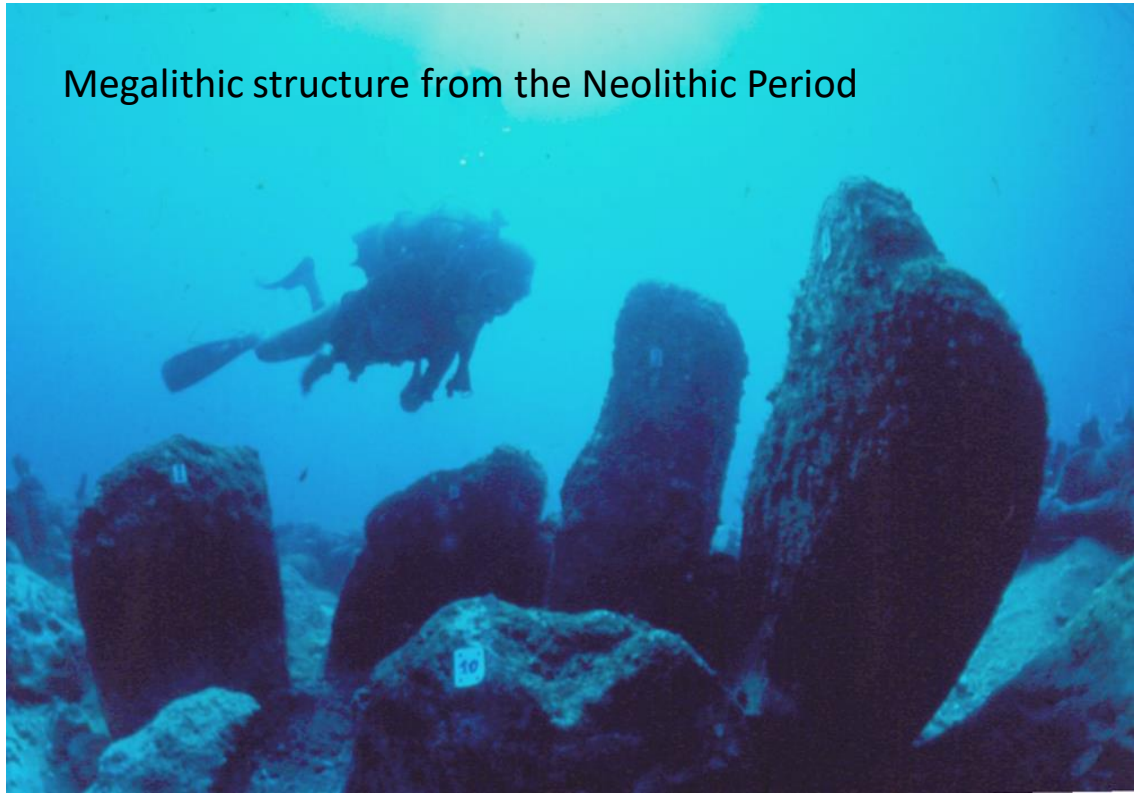
The digital database summarizes the available information about archaeological sites along the coast (582 sites/assemblages) and presents the relevant information (22 observations), and relevant publications for each site.

The database contributes to the research of the underwater archaeological sites, and their publication in scientific and popular journals, books, and conferences.

The public is engaged in the activity and helps to monitor sites and report on the discovery of new sites. The archaeological knowledge is brought to the general public by various activities, including: popular and scientific publications, lectures, TV programs, museum exhibitions and public events.

Category A: Submerged prehistoric settlements

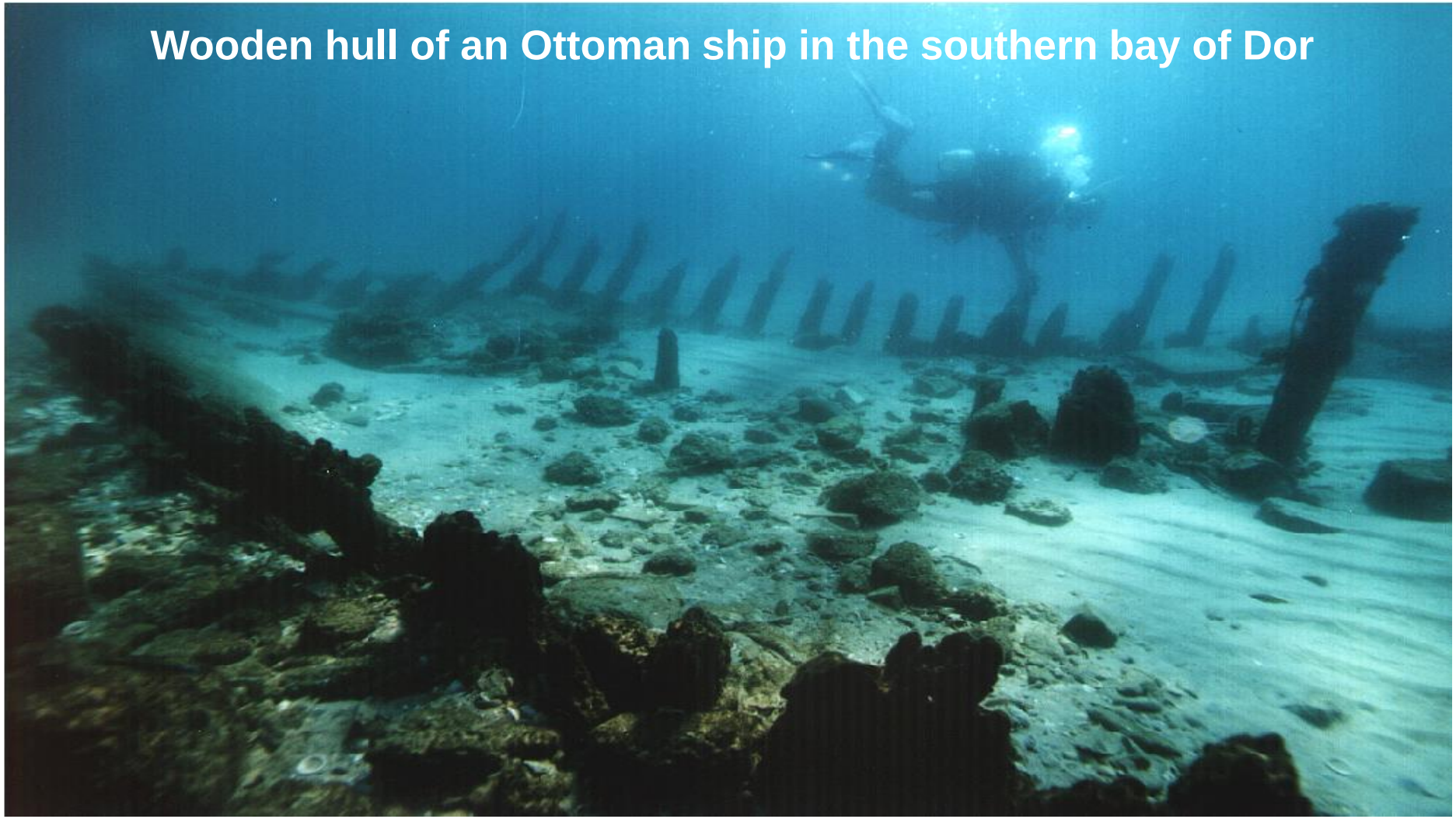
Coastal settlements which were inundated due to post-glacial sea-level rise. Today the sites are
- submerged on the shallow sea bottom at water depth of 1-12 m below sea level



A) Submerged prehistoric settlements

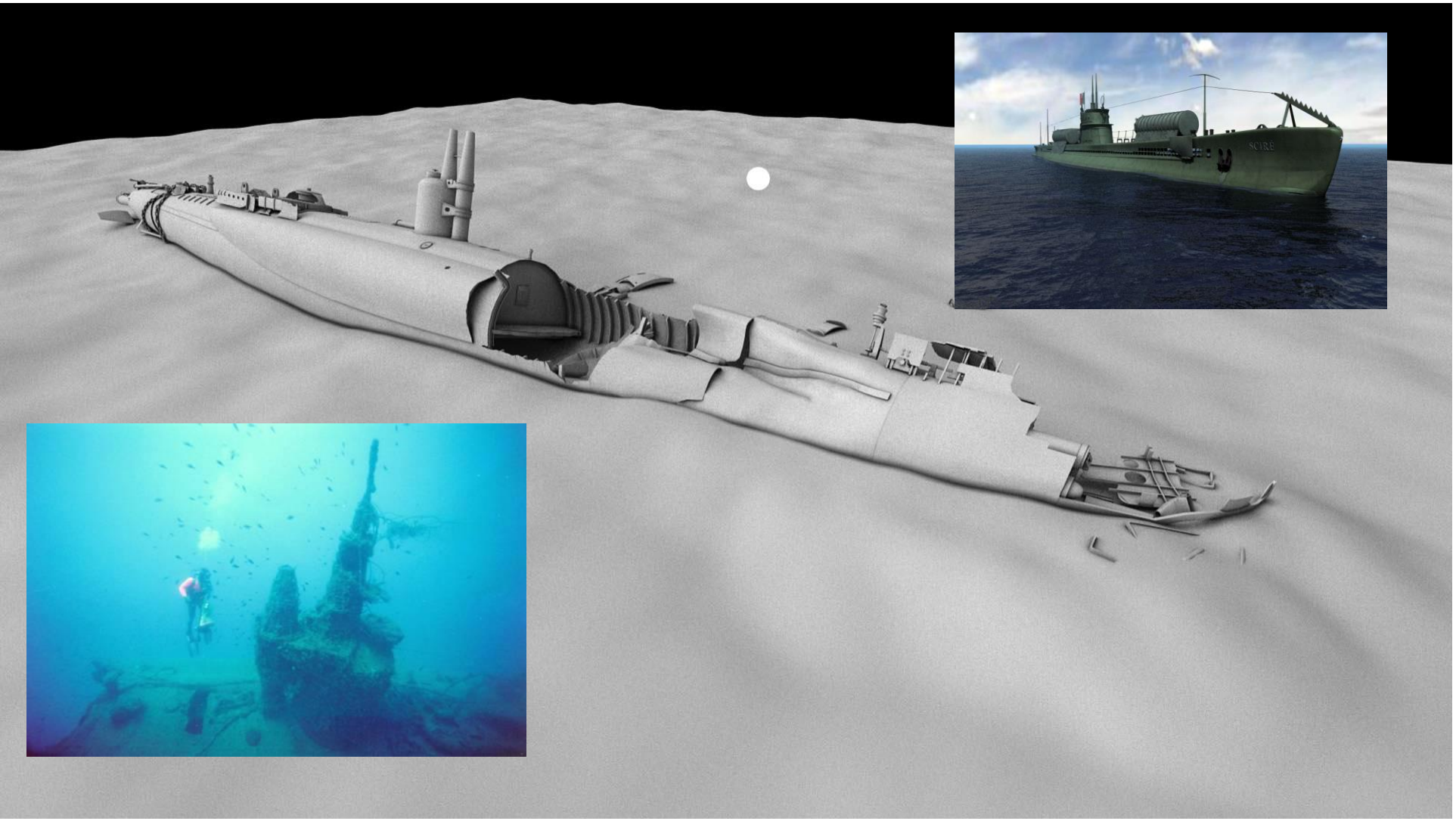
A1 Permanent settlement (dwellings, graves, installations)
A2 Seasonal camp or activity site
A3 Concentration of prehistoric artifacts
A4 Isolated prehistoric artifact

Category B: Shipwrecks and cargoes



Wooden hull of an Ottoman ship in the southern bay of Dor

Category B: The Italian submarine Scire wreck (courtesy: Fabio Ruberti)

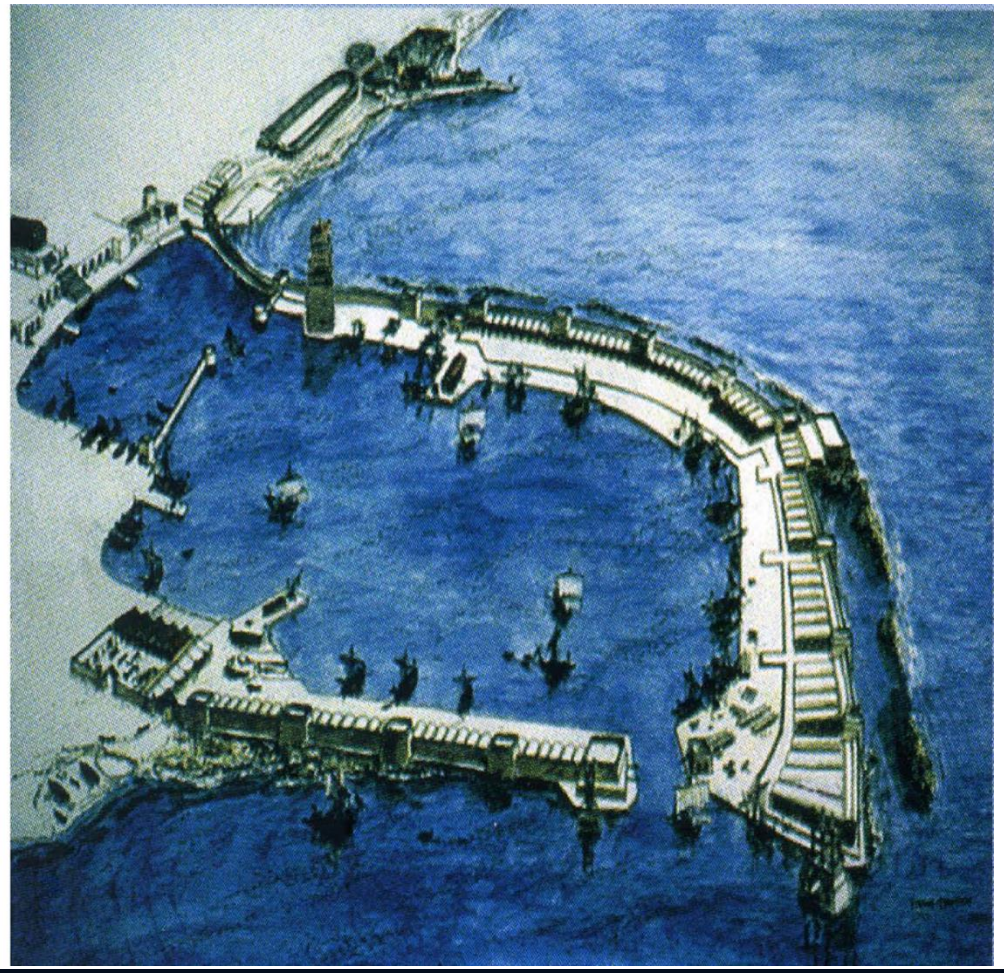


B) Shipwrecks and cargoes, including contemporary watercraft and aircrafts

B1 A wooden hull with, or without cargo
B2 A pile of cargo and artifacts with some hull remains
B3 Assemblage of a wrecked vessel lacking wooden hull
B4 Concentration of similar anchors originating from one wreck
B5 Whole and broken amphorae of the same type scattered in shallow or deep water
B6 A single artifact out of context originated from a watercraft
B7 A single anchor probably lost while anchoring
B8 A pile of ballast stones, probably jettison
B9 Pre - modern or modern metallic wreck B10 mixed artifacts from various periods, in harbor/anchorage

Category C: Harbors, anchorages, mooring and hauling facilities

Caesarea Roman harbor (built 21-10 BC)



C) Harbors and anchorages

C1 Man-made built harbor, at sea and often partly on the coast
C2 Proto harbor natural anchorage (3-7m deep) sunken kurkar ridge with man-made modifications
C3 Deep-water natural anchorage (3-7m deep) partly sunken kurkar ridge
C4 Shallow water natural anchorage (1-3m deep)
C5 Offshore anchor hold (submerged rock used as anchor hold)
C6 Bollards or mooring holes
C7 Slipway
C8 Isolated wooden wharf or jetty
C9 Isolated stone - built marine structure
C10 Harbor in the inlet of coastal river, C11 Silted inland harbor

Category D: Coastal structures and installations

Sea-water well (pumping station) of Installation for salt production, Carmel coast

Rock-cut pool for holding murex shells for the purple dye industry-Shikmona, Haifa

D) Coastal sites: settlements, rock-cut or built coastal facilities

D1 Rock-cut pools operated with seawater by gravity
D2 freshwater installations
D3 Rock cut installation for salt production
D4 quarry
D5 Rock-cut wave trap/wave protection
D6 Architectural element that felled to the sea from an eroded coastal site
D7 Sewer and drainage outlet partly submerged
D8 Foundations of buildings and structures partly submerged
D9 Coastal settlement with sea walls and fortification reaching or entering the sea
D10 Coastal settlement (tell) from historical periods, partly eroded by the sea
D11 Grave/graveyard from historical periods, partly submerged, or eroded by the sea
D12 Modern or pre modern structure or installation of historical or cultural importance

The Database core

The Israel coast was divided into nine survey maps, covering the coast and the shallow continental shelve, where most of the sites are concentrated. Each map contains the location of numbered assemblages. Each assemblage is identified by the number of the survey map and the number of the assemblage within the survey map.

The excel database table contain the relevant data, including 22 observations signifying each assemblage (e.g., coordinates, chronological and typological information water depth, bottom characteristics, legal status and state registration number of protected archaeological sites) + relevant references and selected videos.

Important sites stretching over large area (e.g., archaeological tells, harbors) are depicted by colored polygons, designating their perimeter and importance.

The estimated importance level of each assemblage is evaluated, based on several parameters (e. g., scientific value, accessibility, attractiveness).

Observations taken for each site (A, B refers to field column in the excel database table)

1, 2. (B, C) Number and name of the declaration of the site by the Israel Antiquities Authority

3, 4. (D, E) Name and number of the underwater survey map

5. (F) Common site Name (sub area in survey map)

6. (G) Assemblage number within the survey map

7. (H) Polygon available/not available

8. (I) Short description of the assemblage

9. (J) Assumed Site Period

Observations (continue)

10. (K) Site type according to typology developed for the Israeli coast (see below)

11, 12. (L, M) ITM Lat, Lon new Israel grid

13, 14 (N, O) Water depth/Elevation (Min, Max)

15. (P) Main risks to the site (according to a list of risks established)

16. (Q) Status of Site (In-Situ or Retrieved)

17. (R) Type of sea bottom/site on land

18. (S) Protection of the site by Law

Observations (continue)

19. (T) Municipal authority

20. (U) Visibility-Accessibility (according to categories established)

21. (V) Source of Information

22. (W) Degree of importance of site (evaluated according to scientific value, accessibility, attractiveness)

23. (X) Relevant references (citations and selected PDF files)

24. (Y) Video and TV programs of selected sites

Targeted users/Stakeholders

Name/kind of user	Field	Type of user
Archaeologists	Science	Researchers, excavators, conservators
Historians	Science	Researchers of ancient and contemporary history
Government planning authorities	Planning, monitoring, Regulating, management	Including: national, regional and local planners and regulators on the coast and at sea, coastal and marine infrastructures planners, quarrying planners and regulation authorities
Government nature reserve authorities	Management and monitoring	Management, monitoring, protection
Government antiquities authorities	Management and monitoring	Regulation, authorization monitoring, conservation
Government national and local environmental bodies	Management and monitoring	Management, monitoring, protection

Targeted users/stakeholders

Name/kind of user	Field	Type of user
NGO nature and environment organizations (e.g., The society for the protection of nature)	Protection	Management, monitoring, protection
Local municipal and planning authorities,	Planning, Management and monitoring	Including all the municipal authorities along the 200 km Israeli coast
Armature divers		
Diving clubs		
Developers	Planning	
Architecture and private planning bodies	Planning	

Citizen science and citizen engagement

(Selected activities which has been conducted)

23 Public lectures about the nature and protection of underwater cultural heritage in Israel (total 850 audience)(not including lectures in university courses)

11 Public events (guided diving on shipwrecks, fieldtrips, museum exhibition)

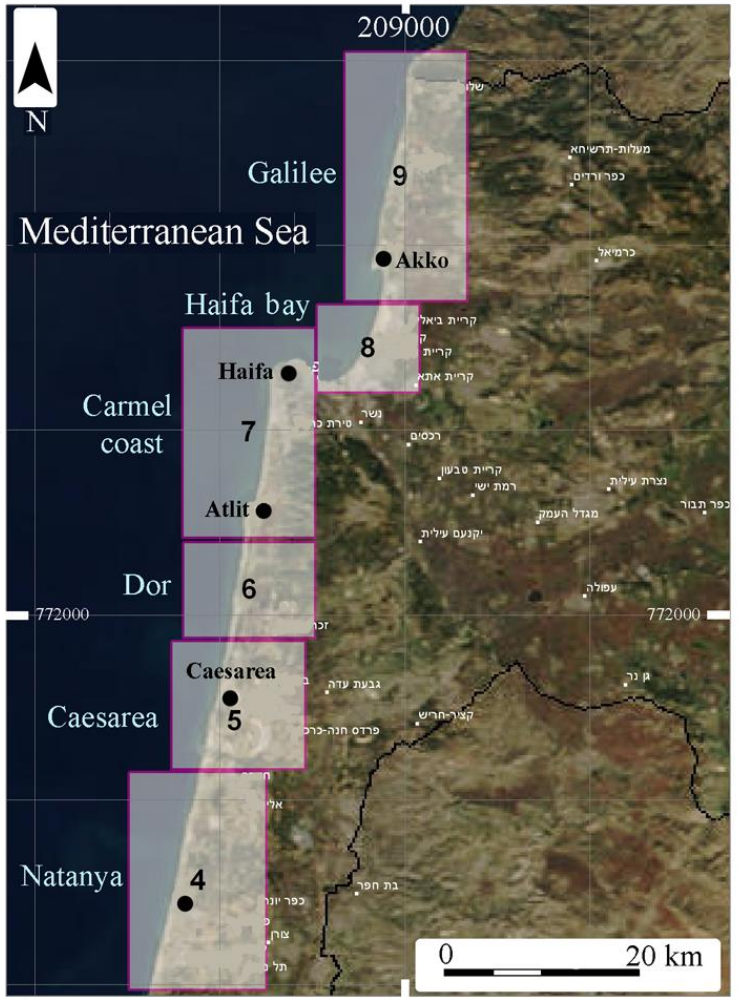
29 reports of citizens about newly discovered underwater heritage

22 public media and TV programs

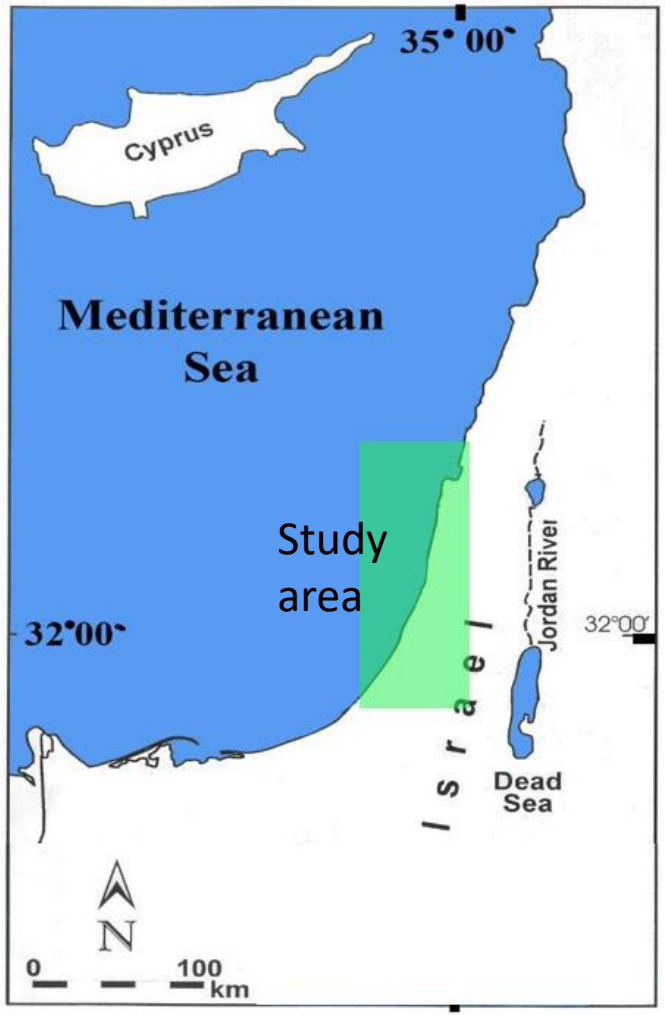
4 popular articles regarding underwater cultural heritage were published

The Mediterranean coast of Israel: survey maps

Marine survey maps- northern Israel



Marine survey maps-southern Israel

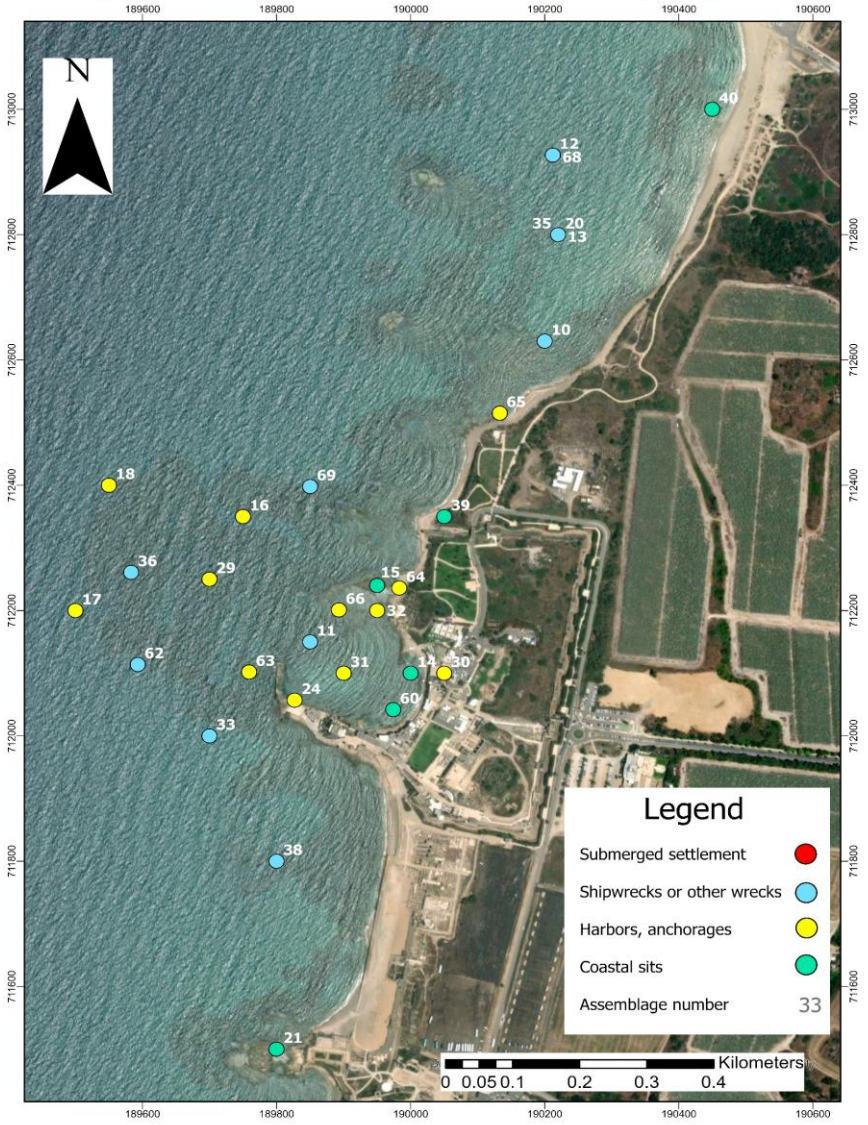


Arc GIS Pro platform products

(Wassim Hamdan)

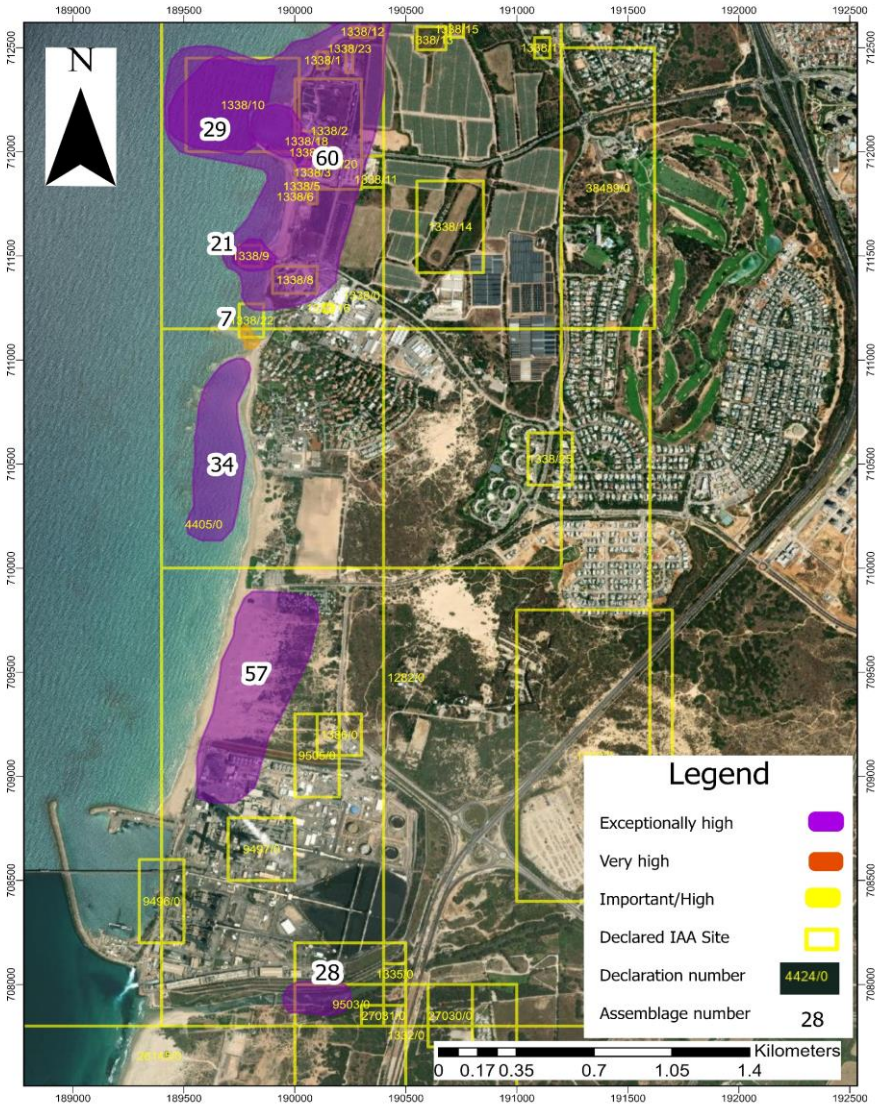
Arc GIS Pro platform: site points

Survey map number 5, sheet number 2, appendix 18



Arc GIS Pro platform: site polygons

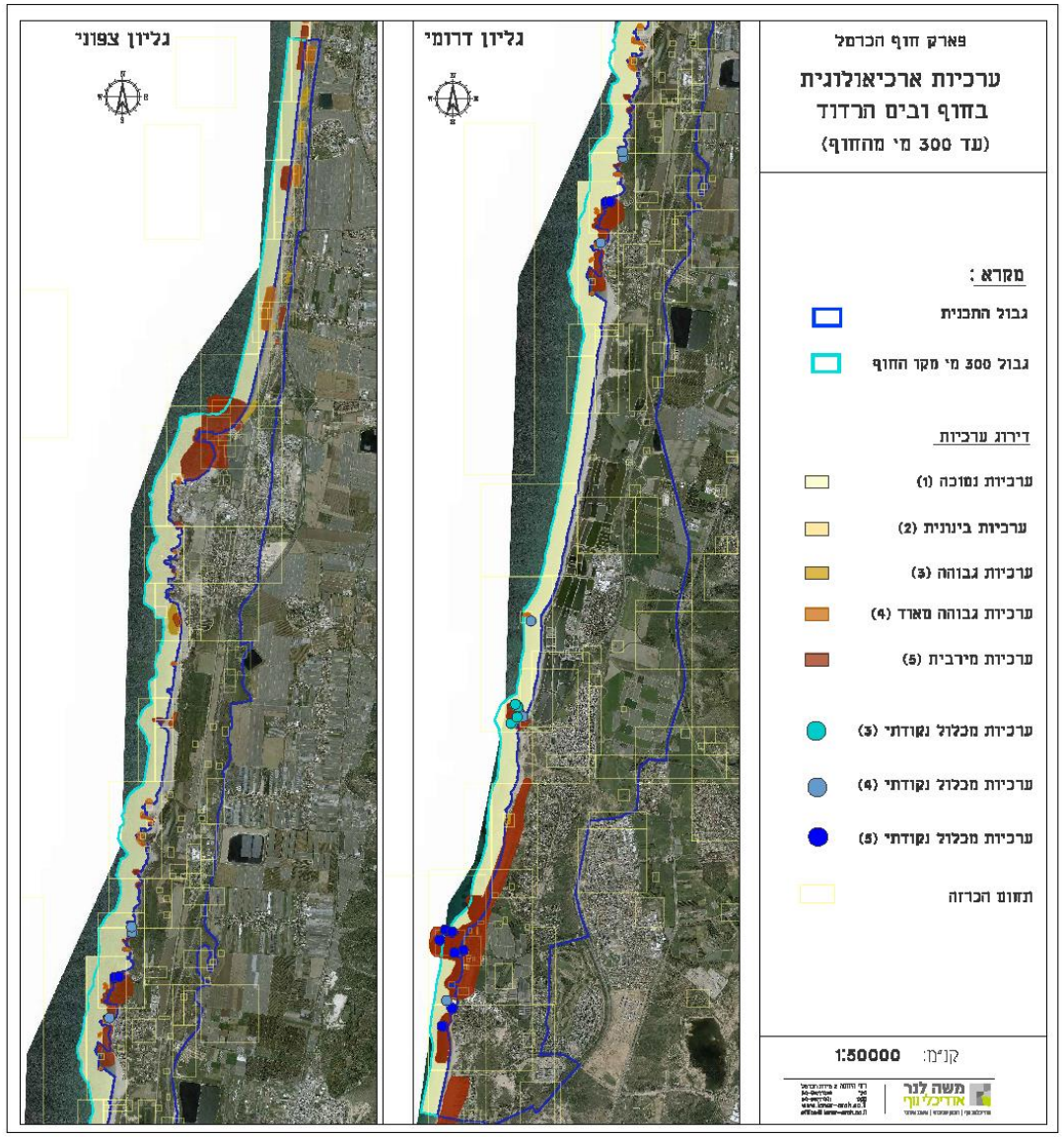
Survey map number 5, sheet number 1, appendix 7



Examples of maps from the data base: Arc GIS interactive platform

Planned visualization platform:
GIS Portal, open access Viewer

An example of Practical application of Arc GIS Pro platform of the Database



An example of a product which has been provided to the Municipal Council of the Carmel coast.

Survey of the underwater and coastal cultural resources in the Carmel coast, evaluation of importance and risk assessment (Text and GIS maps).

Example of products of the ILIAD DTO visualization platforms

Products / DTO visualization platforms:

Database: Excel table with 582 sites and 22 different observations on each site, + references + PDF files of scientific articles + selected videos (recent access: developers).

Interactive Arc GIS Pro platform: with sites depicted as points or polygons (recent access: developers).

ILIAD Marketplace: Description of the pilot, with examples of videos and publications https://ocean-twin.eu/marketplace

Interactive model: The data has been harmonized by Raul Palma according the Ocean Information Model (OIM). Can be accessed by the developers: 1) By site name using Faceted Browser and 2) Interactive maps
(Models: Raul Palma).
Scientific Publications: Are available in Journals and books and in Academia Edu. Site, and will be provided to scholars upon request.

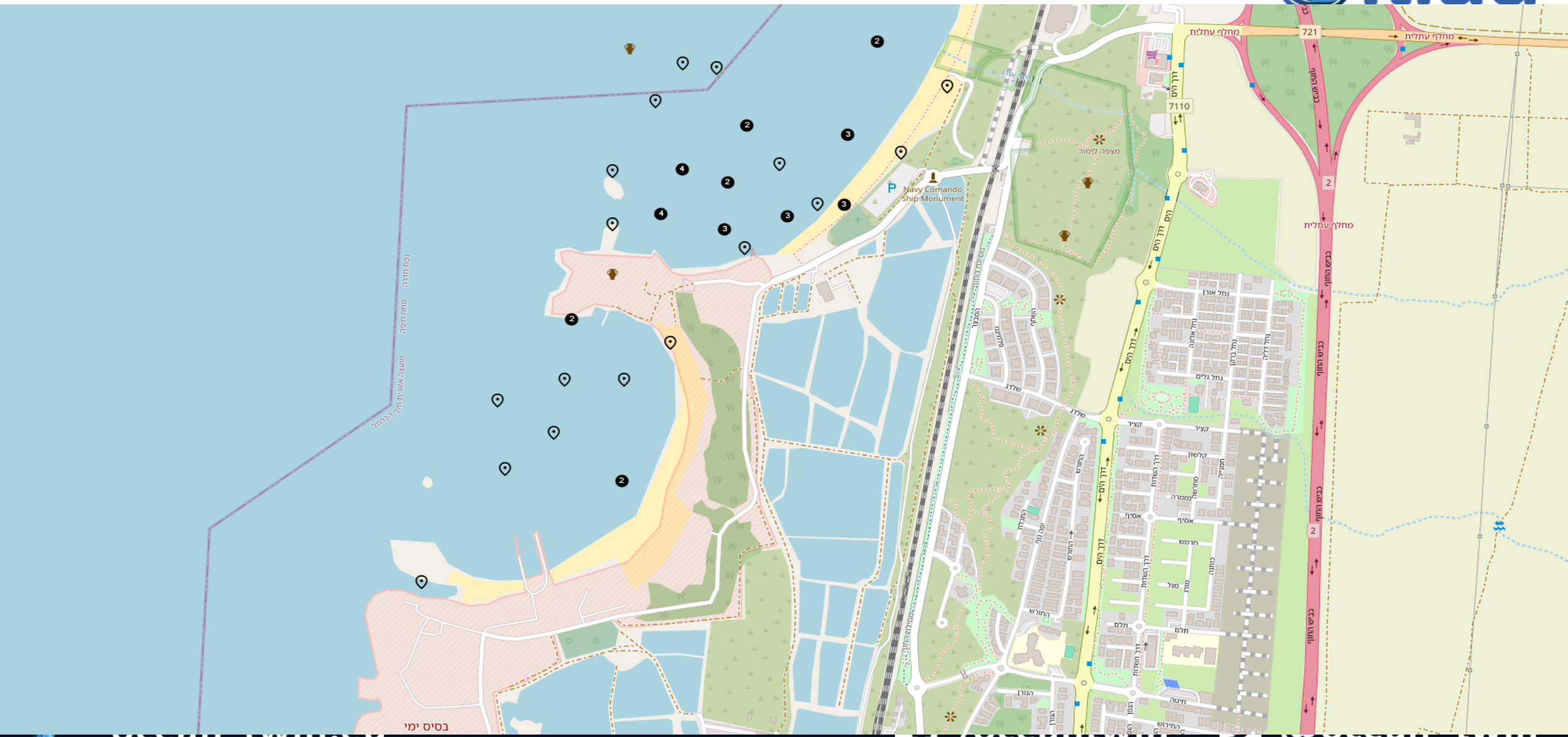
Survey of underwater cultural heritage in the Carmel coast: A product produced for the Carmel coast Municipal Council, to be used for development and conservations efforts.

Planned visualization platforms: Open access portal GIS viewer: To provide partial access to the public to selected sites and data.
Open access GIS layer: In the national site of Israel mapping authority **(Israel Survey),** to provide partial access to the public.

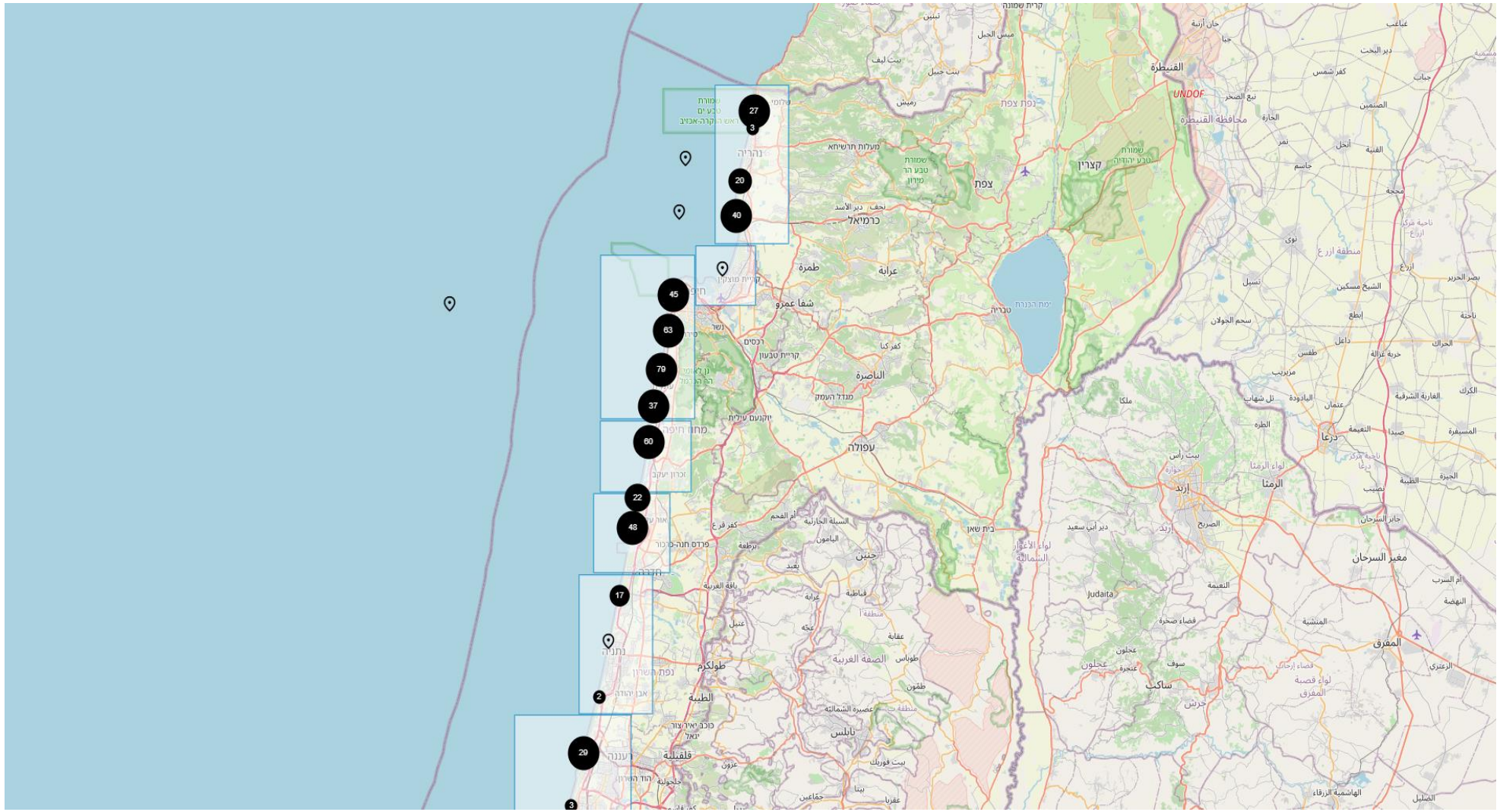
Full access to specific data: To researchers and selected stack holders, upon request.

Interactive map depicting sites in Atlit Bay (With Zoom-in ability)

(ILIAD DTO Platform)



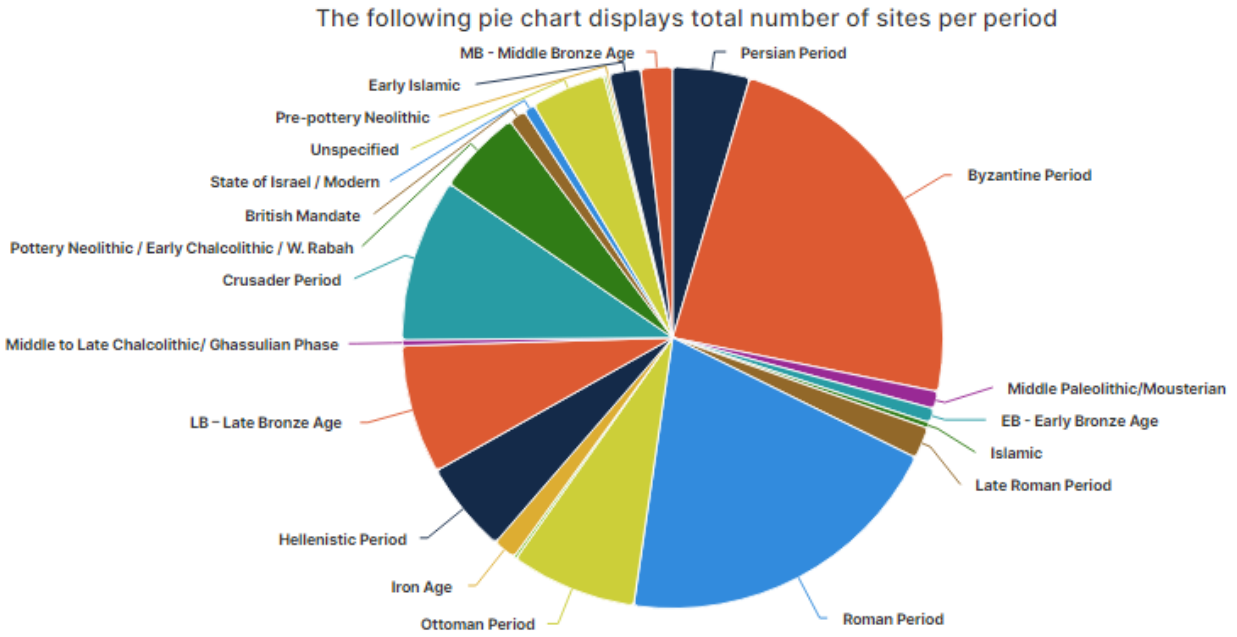
Interactive map depicting the layout of survey maps and number of sites in each circle (With zoom-in application)



Examples of statistical diagrams Obtained from the system

Number of sites per period

Counts of sites per period

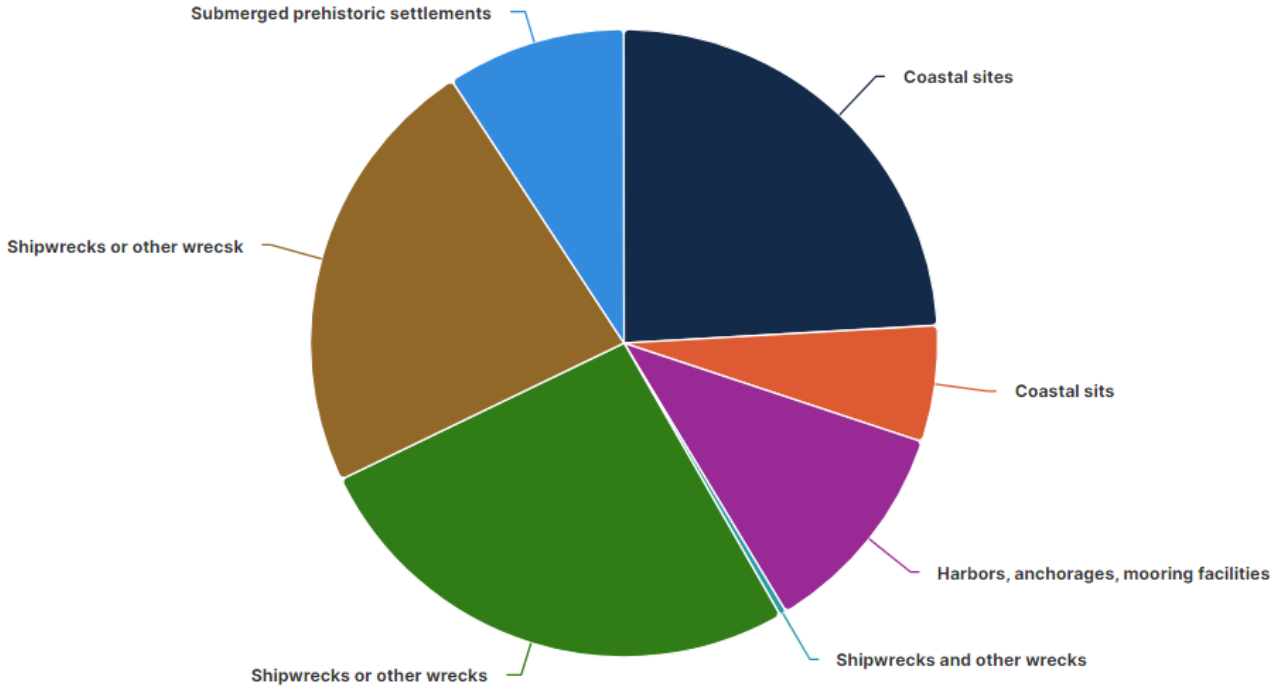


Counts of sites per declaration

Number of sites per type

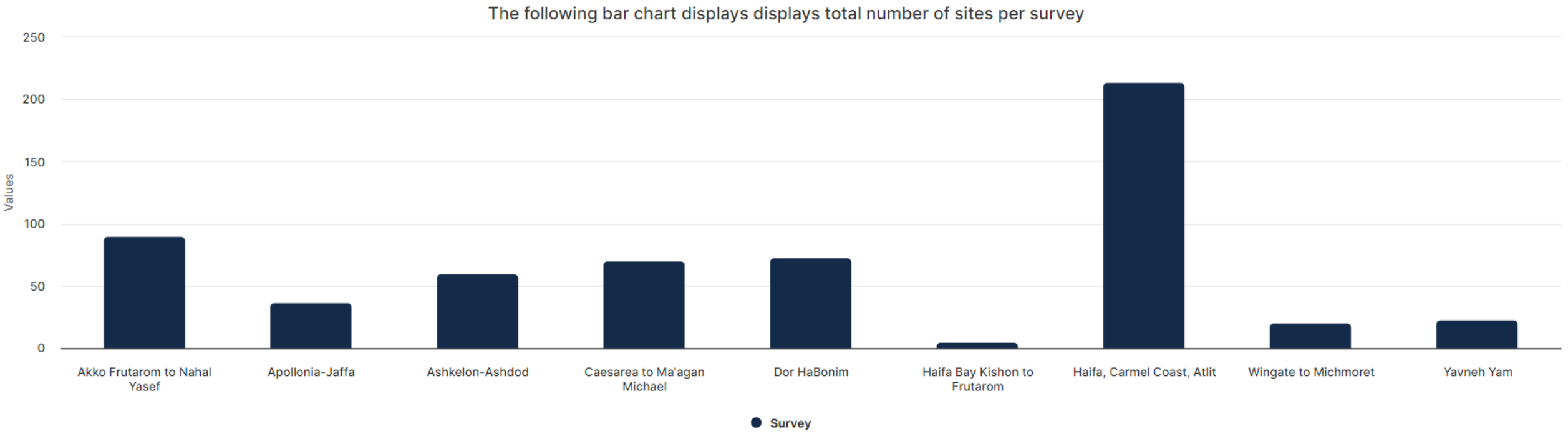
Counts of sites per main type

The following bar chart displays displays total number of sites per main type

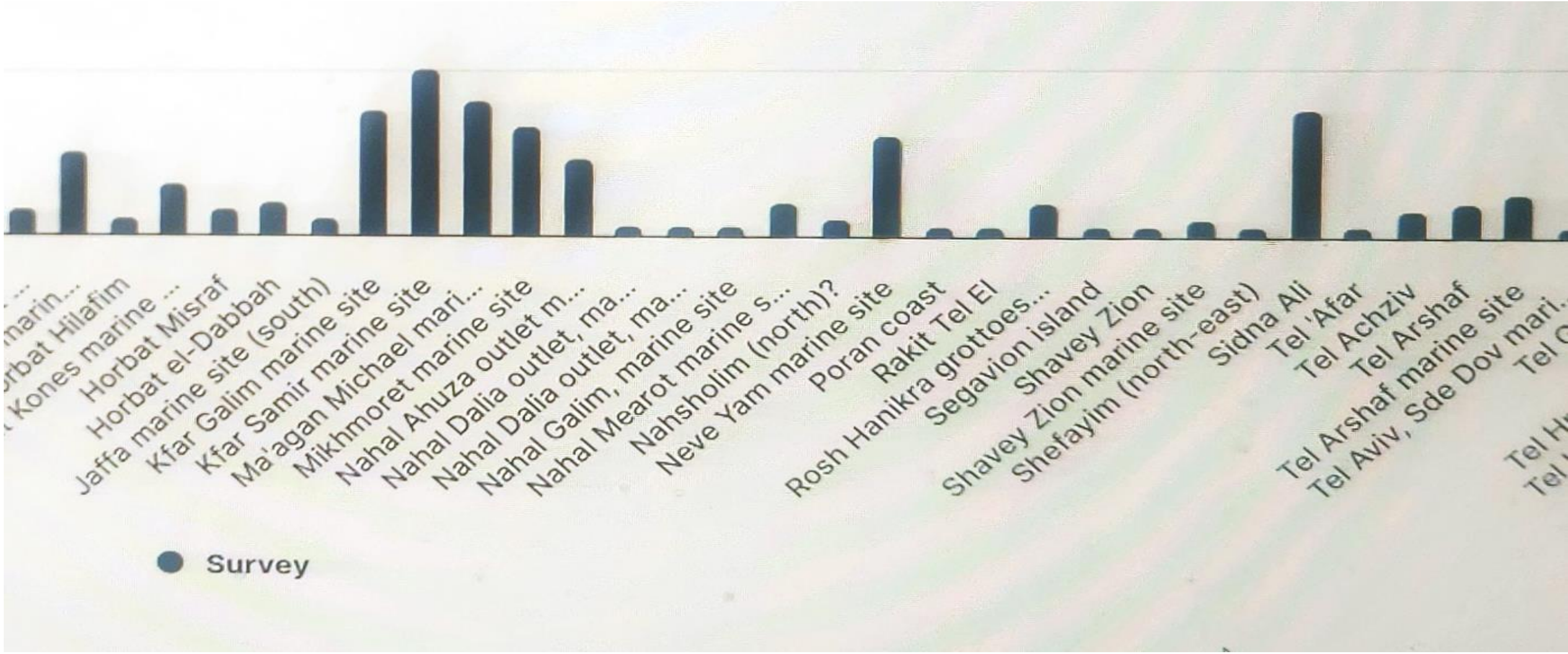


Number of sites per Survey map

Counts of sites per survey



Number of sites per IAA protected site declaration



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