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MARJOLAINE MATABOS
JULIE TOUROLLE
(REM/BEEP/LEP)
& AL.

THE DEEP SEA SPY SYSTEM

Building a marine
images annotation
database from
participative
science

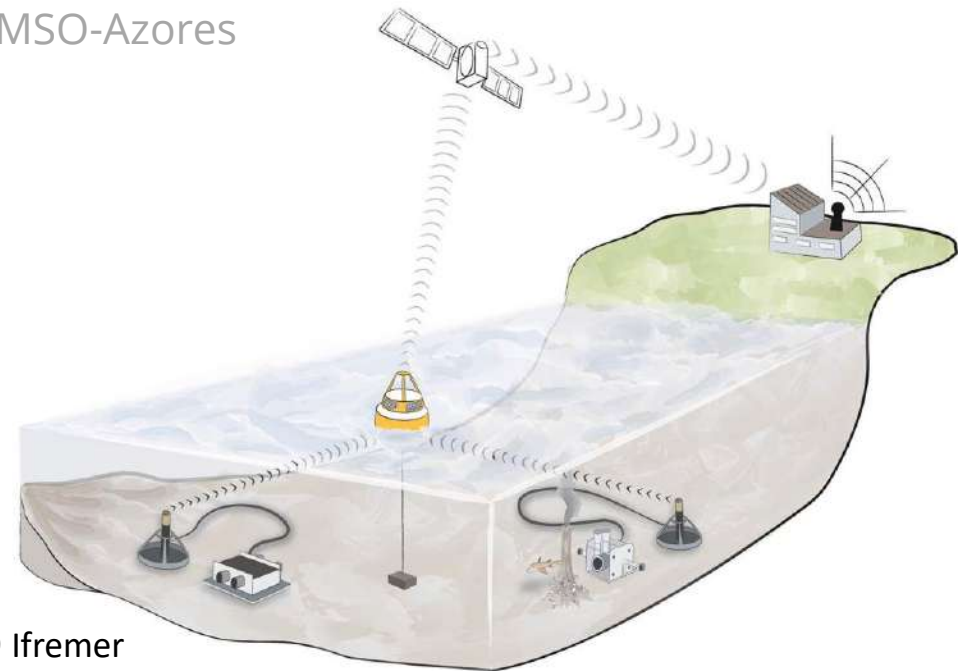
Deep-sea observatories



Long-term continuous monitoring

- Cabled or autonomous
- Presence 24h / 365 j / 20+ years
- Integrated, multidisciplinary approach
- High resolution sampling
- Real-time or near real-time : event detection capacity, remote sampling
- *In situ* monitoring

EMSO-Azores



Deep-sea observatories

EMSO-Azores 2010-...

Mid-Atlantic Ridge
*Tour Eiffel, Lucky
Strike (1700 m)*

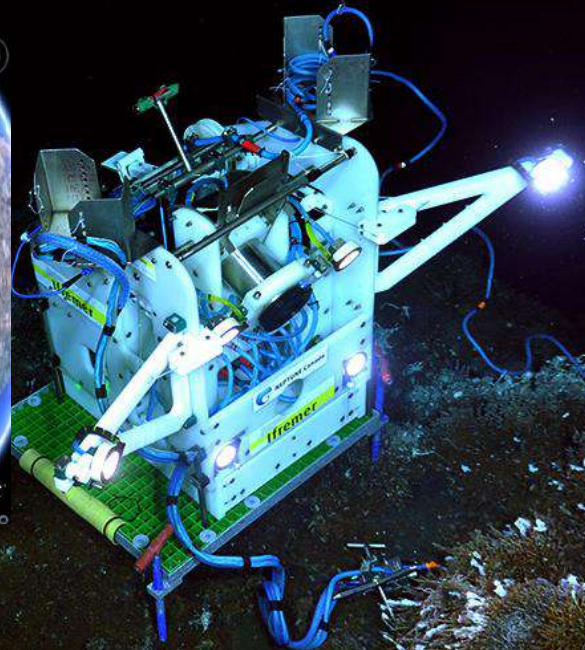


Ocean Networks Canada 2011-...

Juan de Fuca Ridge
*Grotto, Main
Endeavour (2200 m)*



Imagery
2 min/6 hrs/365 days



TEMPO ecological module



Imagery
20 min/4 hrs/365 days

Hydrothermal vents

Marine protected areas

Specialized fauna: hot toxic fluid/narrow physico-chemical gradients

Massive sulphide mineral deposits

Mid-Atlantic ridge
Tour Eiffel, Lucky Strike
1700 m

Mussel beds: *Bathymodiolus azoricus*

Juan de Fuca ridge
Grotto, Main Endeavour Field
2200 m

Tubeworms: *Ridgeia piscesae*

Ecosystem functioning: What are the environmental drivers of faunal distribution and ecosystem functioning? Spatial and temporal characterisation of communities.

What are the ecological impacts of a potential industrial exploitation ?

Annotate visible inhabitants

TEMPO-MINI 2013-07-15 06:00:21

Pycnogonids



Whelk



Gastropods



Tubeworms



Scale worms



Fish



Annotate visible inhabitants

EMSO Azores 2015-07-29 02:57:07



Crabs

Shrimp

Some examples of data analysis

MOMAR-D 2015-04-07 17:46:51

TEMPO : 2014-2015 deployment (2 min of video sequences every 6h)

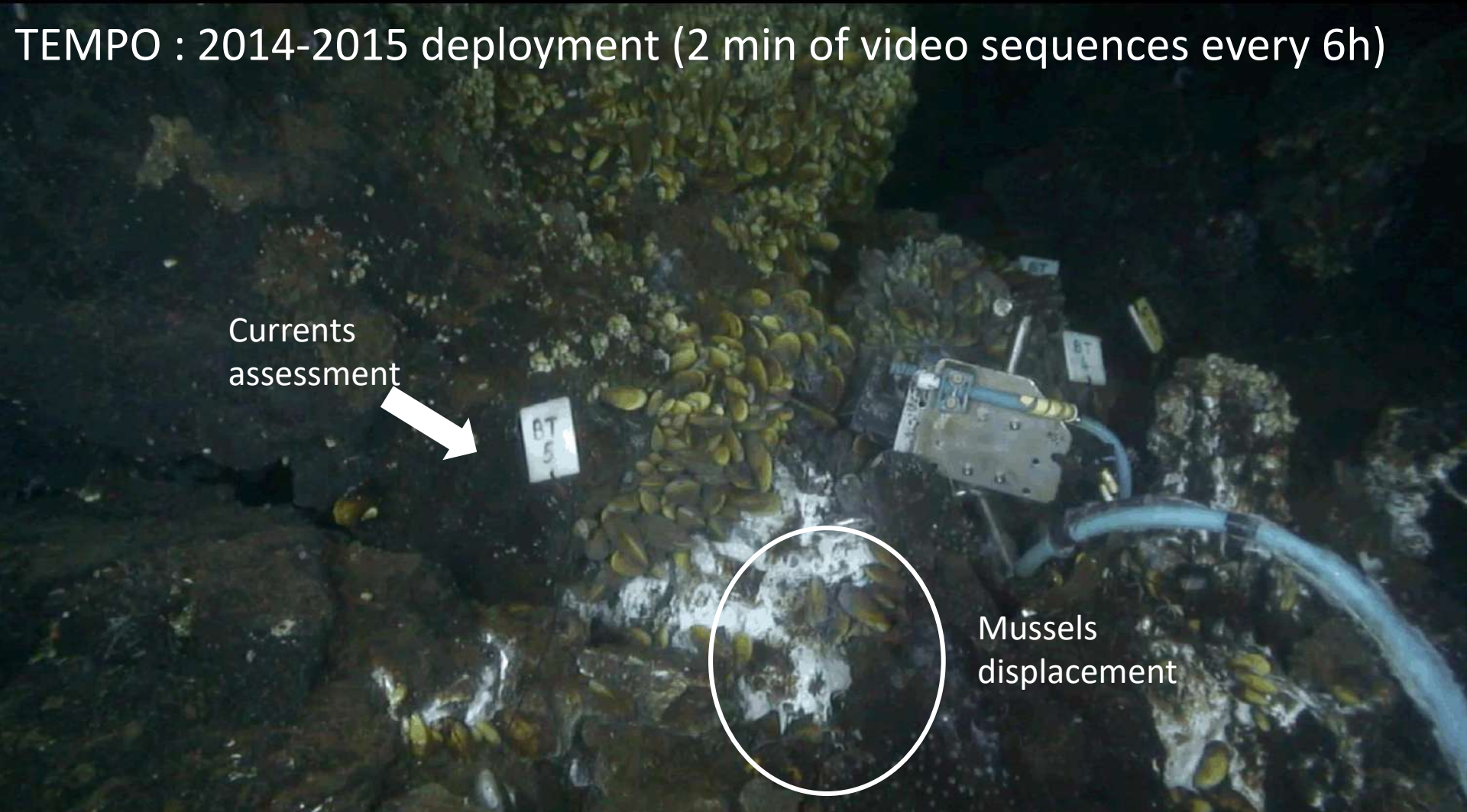
Currents
assessment



BT
5



Mussels
displacement



Imagery archive

780 video hours/year...

> 5000 video hours (> 10 Tb)

20 work hours to annotate **1 video hour**

...more than 11 years to annotate the
present whole dataset
(which increases every year) !

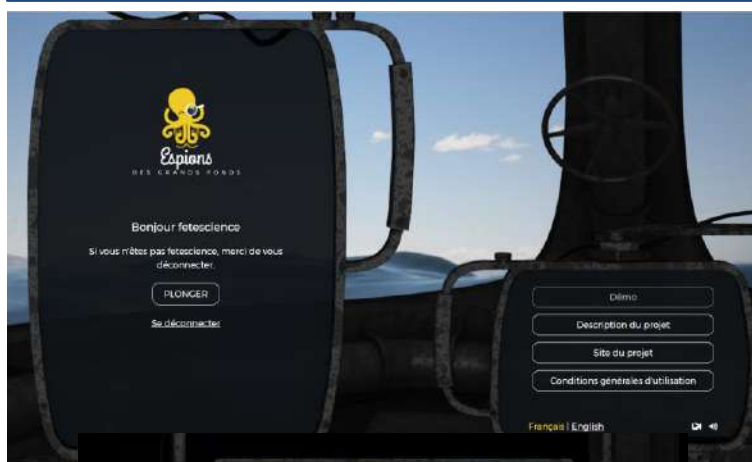
**To proceed such a video archive
scientists need the help of citizen**



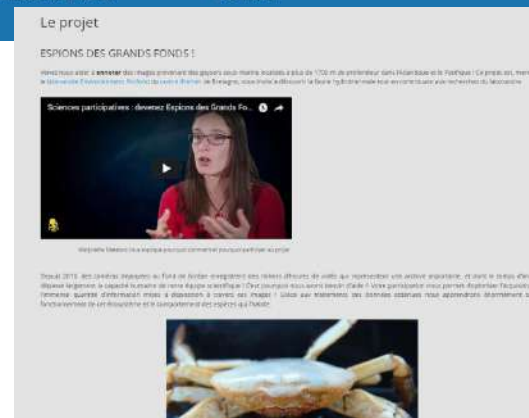
Development of a citizen science project

Deep Sea Spy

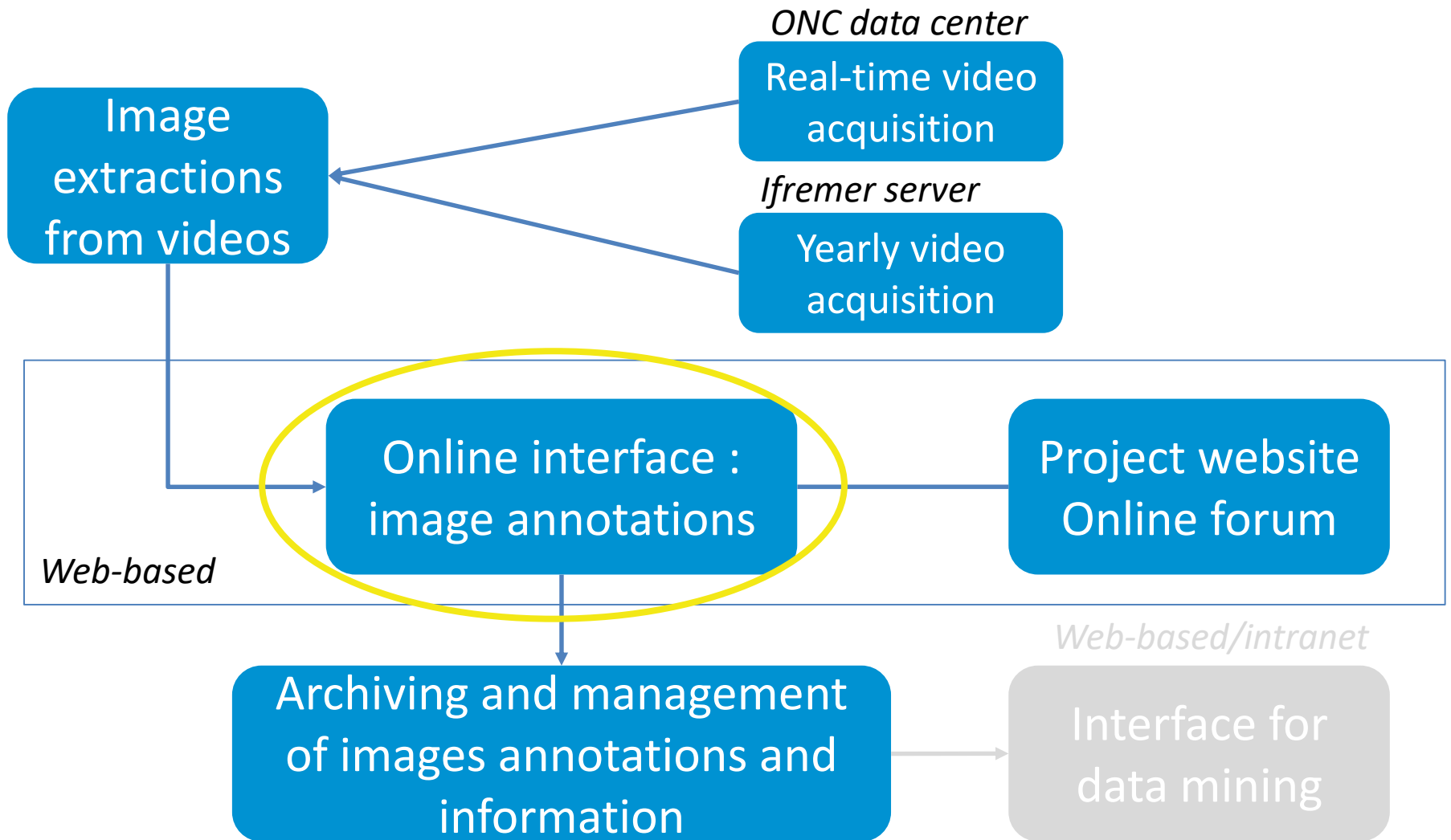
An online annotation tool



A project website



Development of a citizen science project



A web-based application to annotate species

- A web-based software for manual image processing that will help gather useful information for scientists
- A fun and engaging interface to raise awareness among the general public to deep-sea ecosystems

- **Available online (internet)**
- **Built as a game**
- **Tutorial**
- **Levels (and virtual rewards)**
- **Data stored in pixels**





Join us and find animals in images
collected from deep-sea geysers
beyond 1 700 m deep !

CONNECTION

vt.0.1

Demo

Project description

Website

Terms of Use

English



TEMPO-MINI 2014-07-24 05:00:21



fetescience
Disconnect



JUAN DE FUCA RIDGE SPECIES TO LOOK FOR

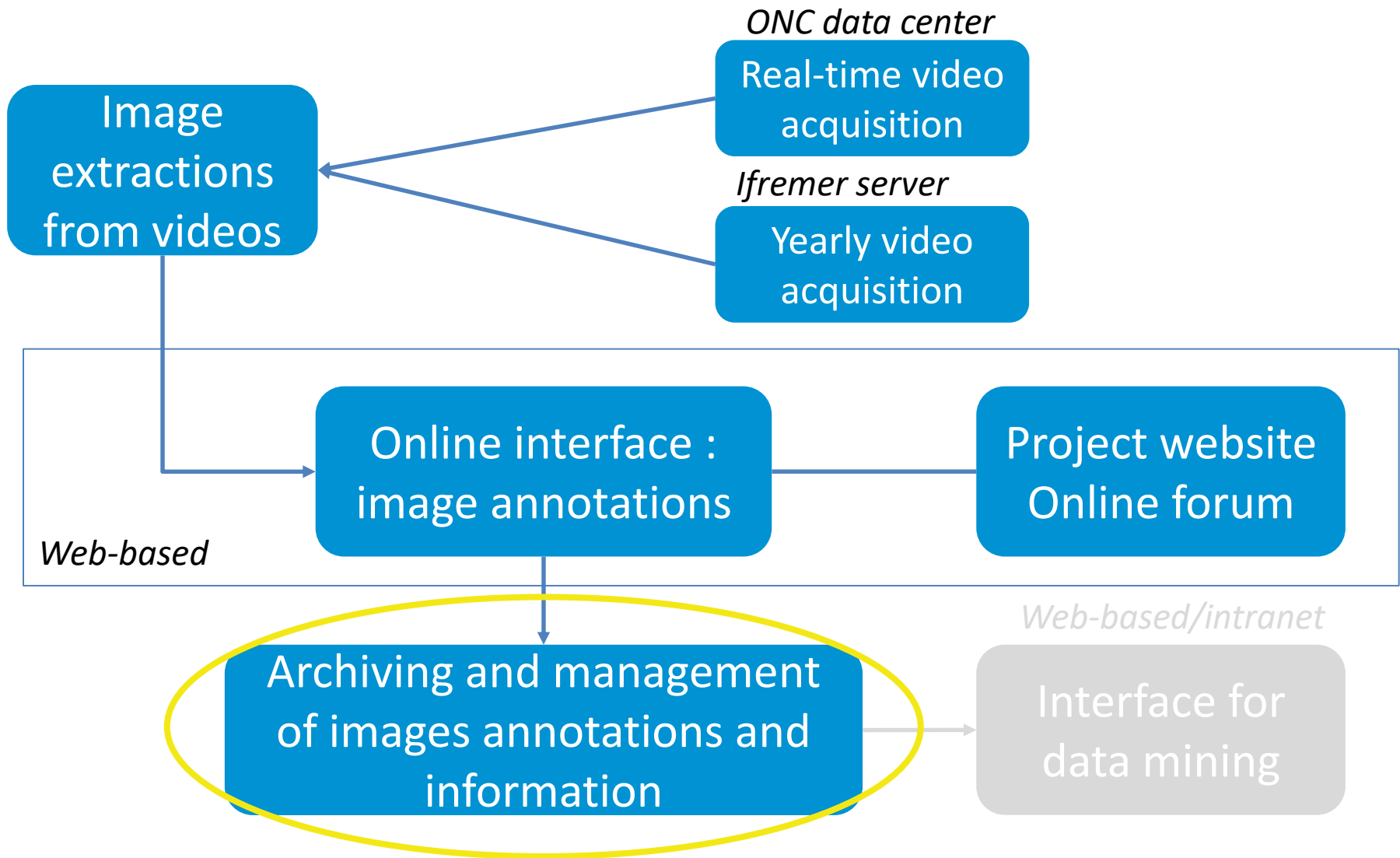
- Buccinid snail (7)
- Polynoid worms
- Pycnogonid (3)
- Spider crab
- Zoarcid fish

HOW TO ANNOTATE the Buccinid snail



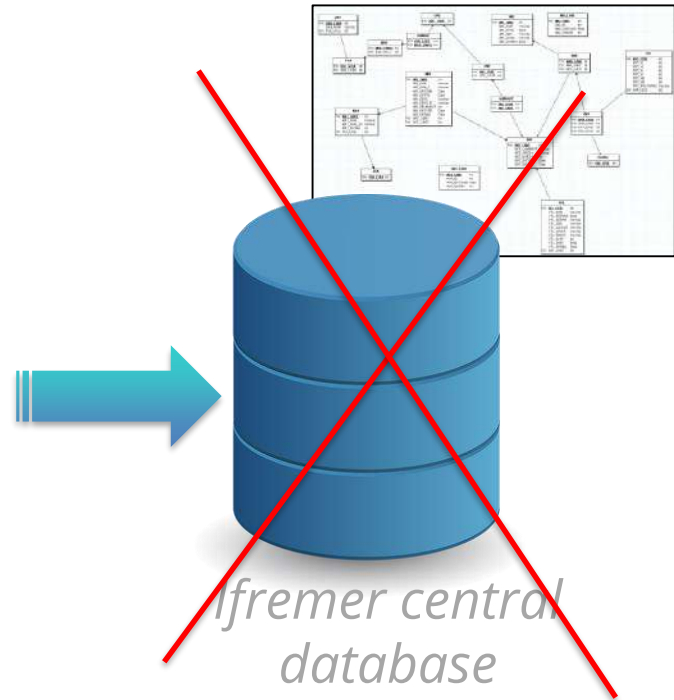
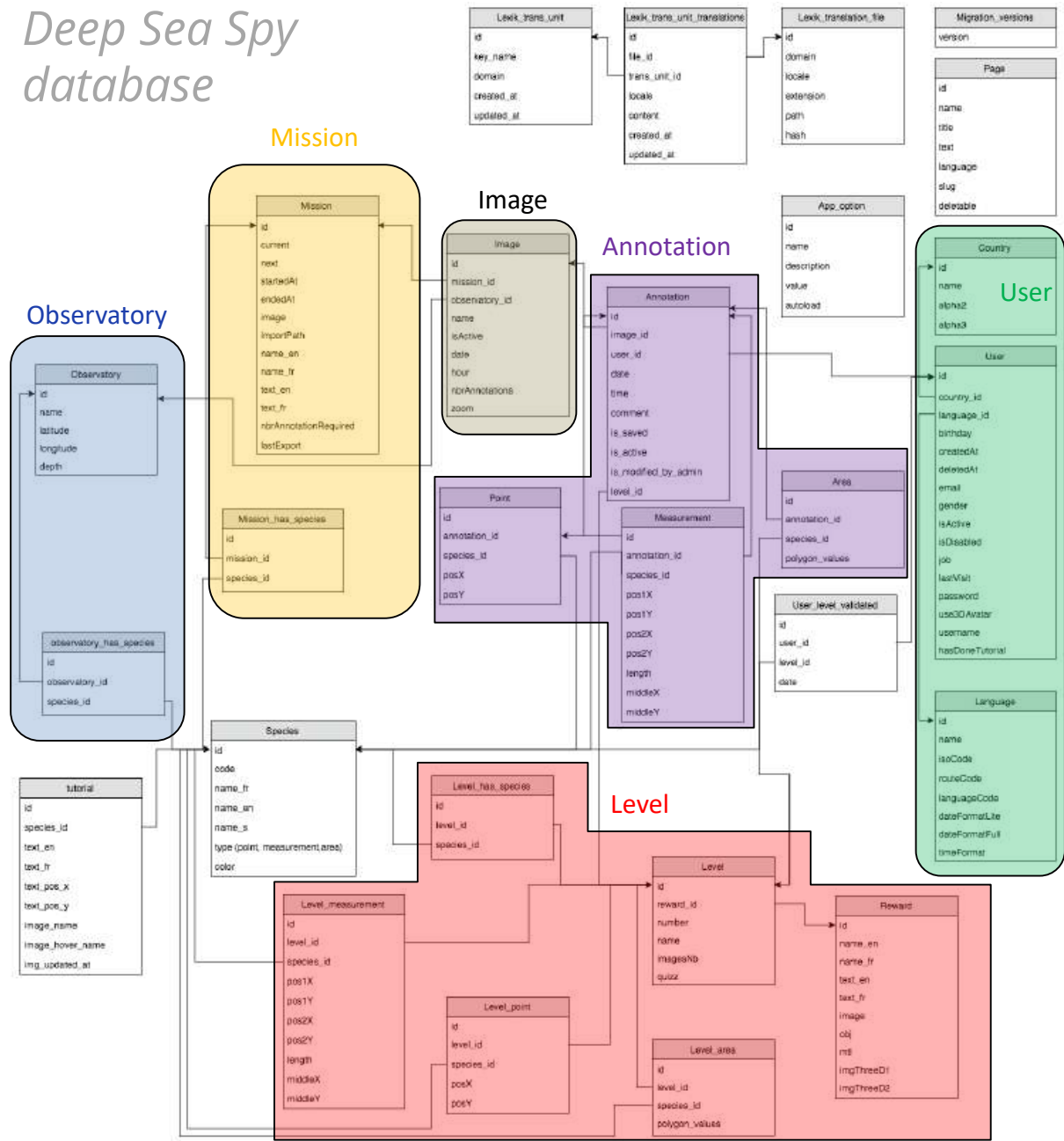
Buccinum
thermophilum

Development of a citizen science project



Deep Sea Spy database

Citizen Science & Imagery Data



- Standardisation...
- Taxonomy
 - Parameters

Mission 1: *Buccinum thermophilum*

Total number of buccinid annotated : 140 316

Total 'real' number of individuals annotated:

- No threshold: 35 765
- Agreement threshold:

25% : 18 582

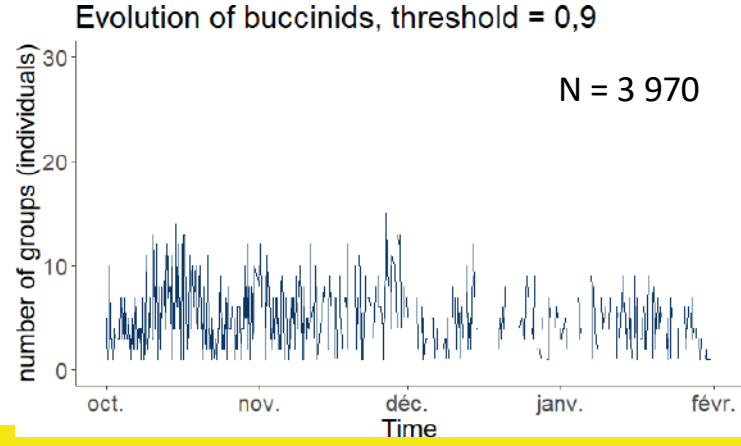
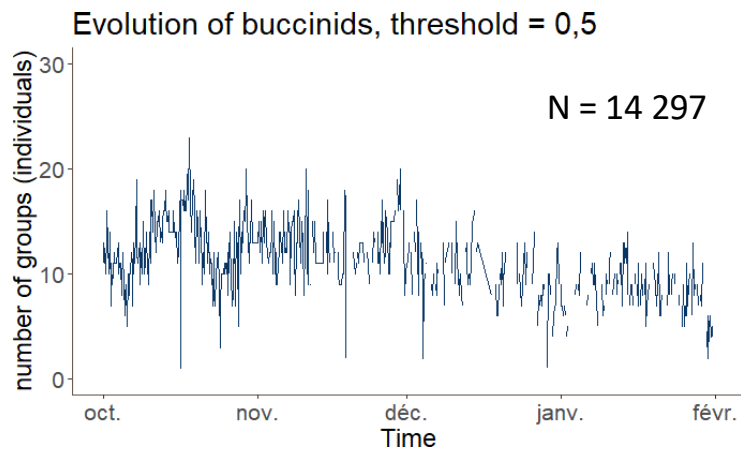
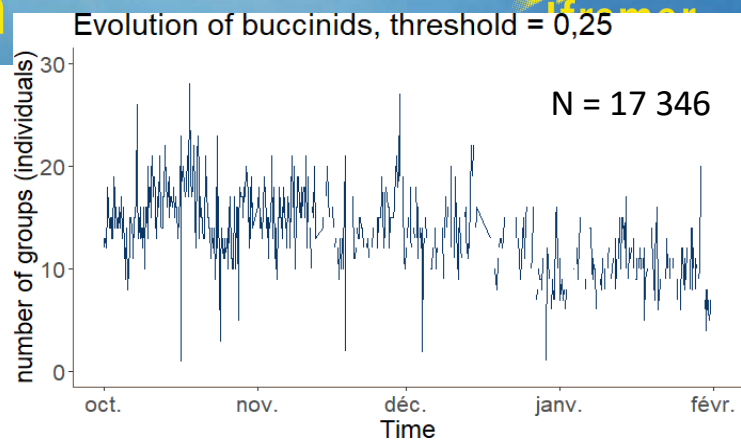
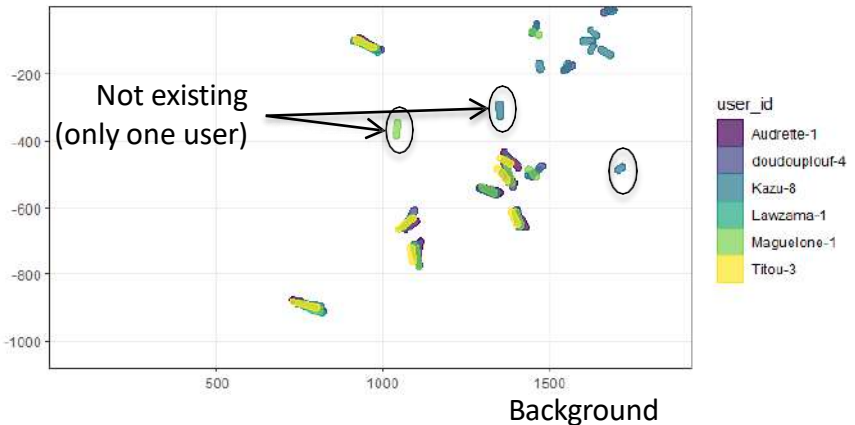
50% : 15 325

75% : 12 609

90% : 5 587



Buccinum thermophilum





mean Average Precision (mAP): proportion of correct findings -> high score = few false positives

Recall : proportion found of real objects -> if maximised, high proportion of false positive

Intersection over Union (IoU) -> match between the predicted rectangle and the reference annotation one :
0.5 (standard value) - 0.01 (high tolerance).



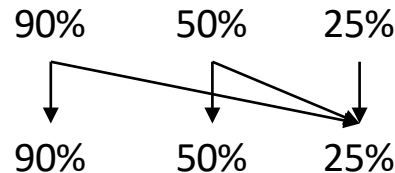
	Training set	
	Expert	Citizen
Zoom	mAP: 91% - 94% Recall: 92% - 95%	mAP: 44% - 80% Recall: 52% - 85%
Large view	mAP: 81% - 87% Recall: 83% - 88%	mAP: 69% - 82% Recall: 77% - 86%

Citizen data

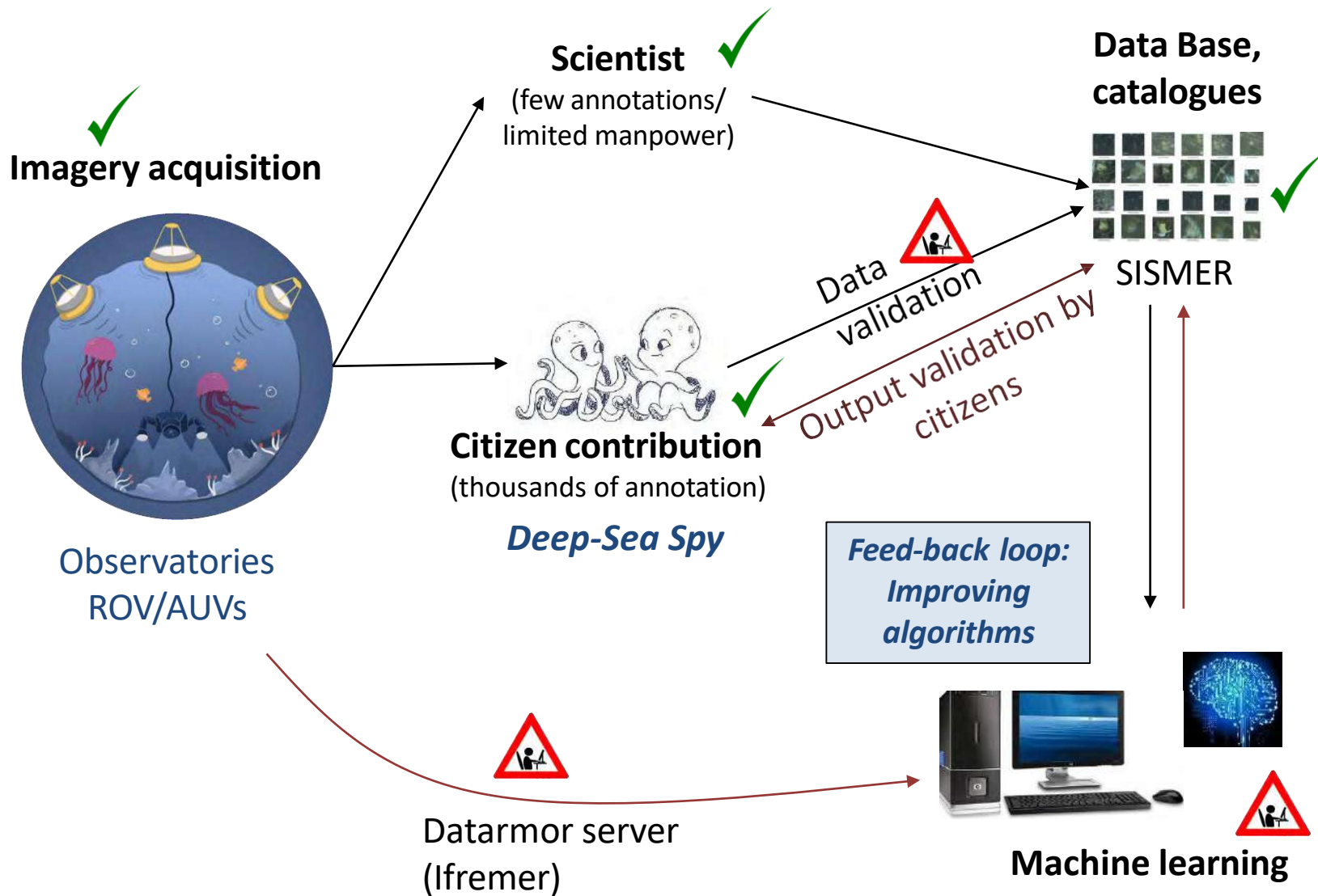
Training set
(500-700 images)

Validation set

Agreement threshold

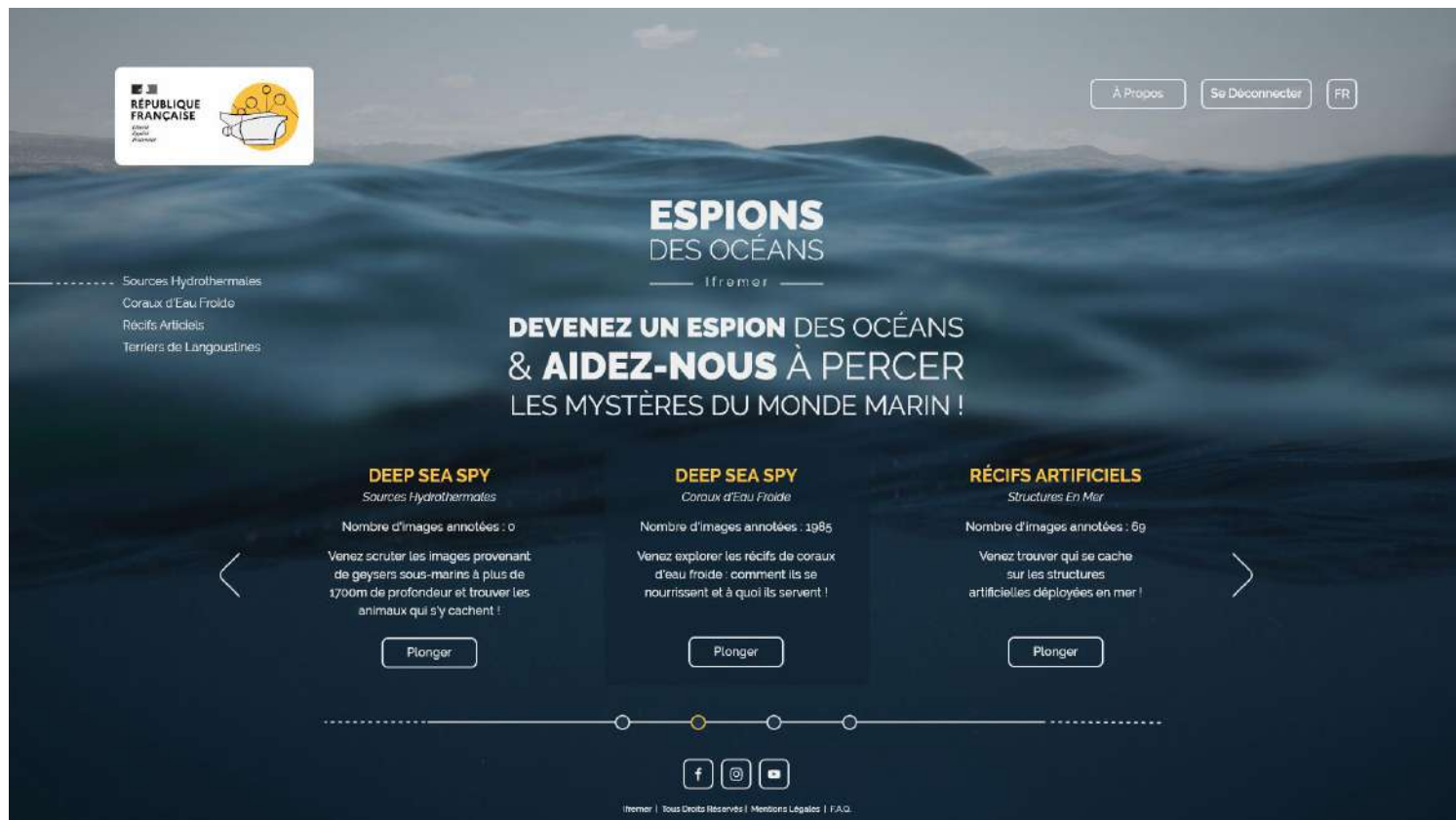


Best values for training set with 50% agreement evaluated on the same corpus



New version of Deep Sea Spy to come!

A platform dedicated to image annotation by citizen for the study of marine ecosystems



The screenshot shows the main page of the 'Espions des Océans' website. At the top left is the logo of the French Republic (RÉPUBLIQUE FRANÇAISE) and the Ifremer logo. On the top right, there are navigation buttons: 'À Propos', 'Se Déconnecter', and 'FR'. The main heading is 'ESPIONS DES OCÉANS' with the Ifremer logo below it. The central text reads: 'DEVENEZ UN ESPION DES OCÉANS & AIDEZ-NOUS À PERCER LES MYSTÈRES DU MONDE MARIN !'. On the left side, there is a vertical menu with categories: 'Sources Hydrothermales', 'Coraux d'Eau Froide', 'Récifs Artificiels', and 'Terriers de Langoustines'. Below the main heading, there are three featured sections, each with a title, subtitle, description, and a 'Plonger' button. The first section is 'DEEP SEA SPY Sources Hydrothermales' with 0 annotated images. The second is 'DEEP SEA SPY Coraux d'Eau Froide' with 1985 annotated images. The third is 'RÉCIFS ARTIFICIELS Structures En Mer' with 69 annotated images. At the bottom, there are social media icons for Facebook, Instagram, and YouTube, and a footer with the text 'Ifremer | Tous Droits Réservés | Mentions Légales | FAQ'.

RÉPUBLIQUE FRANÇAISE
Ifremer

À Propos Se Déconnecter FR

ESPIONS DES OCÉANS

Ifremer

DEVENEZ UN ESPION DES OCÉANS & AIDEZ-NOUS À PERCER LES MYSTÈRES DU MONDE MARIN !

- Sources Hydrothermales
- Coraux d'Eau Froide
- Récifs Artificiels
- Terriers de Langoustines

DEEP SEA SPY

Sources Hydrothermales

Nombre d'images annotées : 0

Venez scruter les images provenant de geysers sous-marins à plus de 1700m de profondeur et trouver les animaux qui s'y cachent !

Plonger

DEEP SEA SPY

Coraux d'Eau Froide

Nombre d'images annotées : 1985

Venez explorer les récifs de coraux d'eau froide : comment ils se nourrissent et à quoi ils servent !

Plonger

RÉCIFS ARTIFICIELS

Structures En Mer

Nombre d'images annotées : 69

Venez trouver qui se cache sur les structures artificielles déployées en mer !

Plonger

f i y

Ifremer | Tous Droits Réservés | Mentions Légales | FAQ

Shore Spy/Espions des côtes

P.O Liabot, A. Carlier, M. Marzloff – DYNECO/LEBCO



RÉPUBLIQUE FRANÇAISE
L'union fait la force

Dém Espions Des Océans Connexion FR

Vous allez visiter le site Espions des Océans dans un nouvel onglet

Vous allez visiter le site Espions des Océans dans un nouvel onglet

Espions DES CÔTES

DEVENEZ UN ESPION de la rade de BREST

Lorem Ipsum dolor sit amet, consectetur adipiscing elit. Cras ut tempus diam. Proident aliquet, enim ut eleifend efficitur, mi nisl malesuada nisl, eget pellentesque lectus ante non lacus. Curabitur sit amet neque eu arcu semper mattis. Sed eu turpis

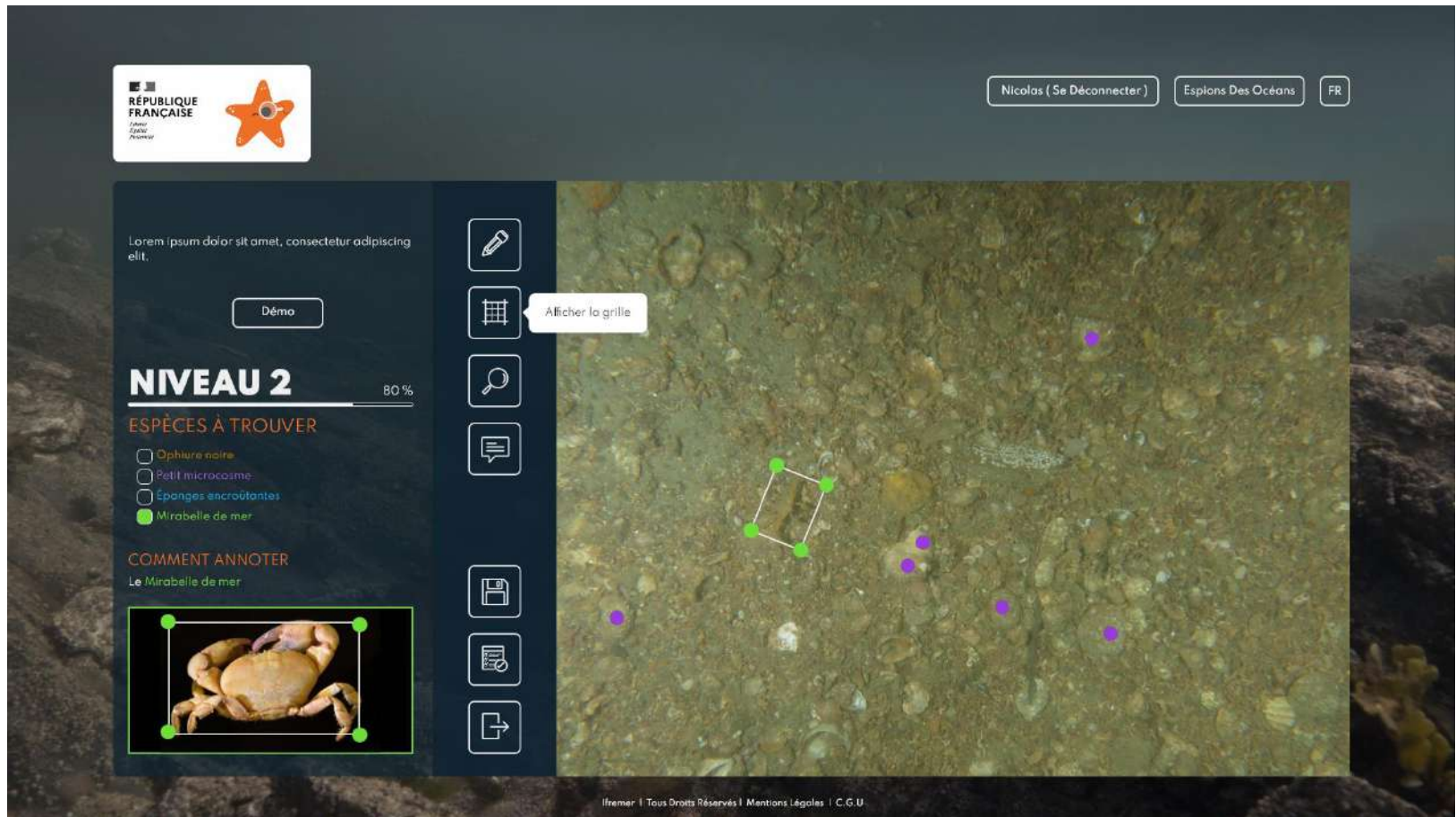
Plonger

Veuillez vous connecter ou créer votre compte avant de plonger.

Ifremer | Tous Droits Réservés | Mentions Légales | C.G.U

Shore Spy/Espions des côtes

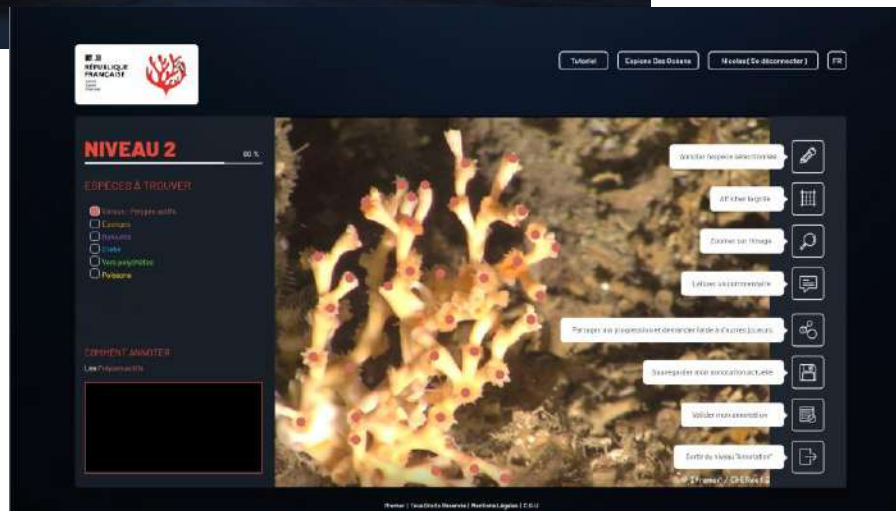
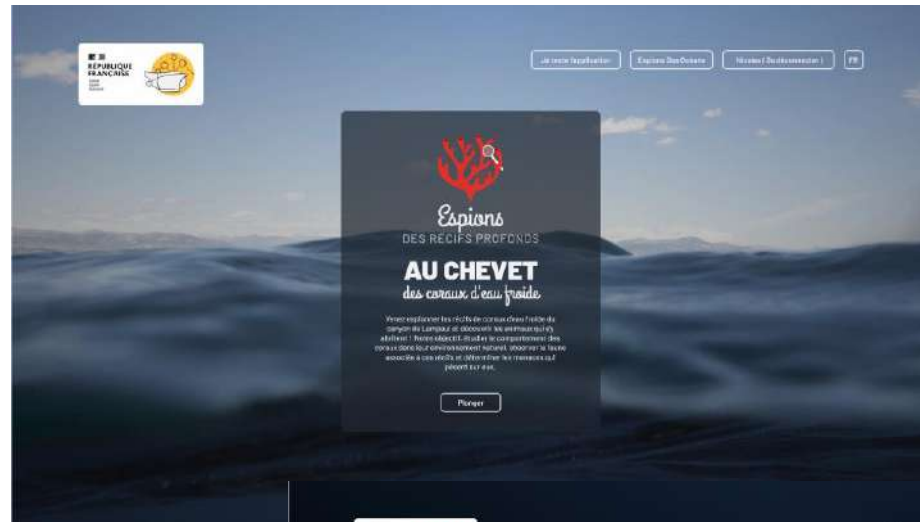
P.O Liabot, A. Carlier, M. Marzloff – DYNECO/LEBCO



The screenshot displays the Ocean Spy web application interface. At the top left, there is a logo for the République Française (French Republic) and a star icon. The top right shows a user profile for 'Nicolas (Se Déconnecter)', the project name 'Espions Des Océans', and a language selector 'FR'. The main content area is divided into a left sidebar and a central image. The sidebar contains a 'Démonstration' button, a progress indicator for 'NIVEAU 2' at 80%, and a checklist of species to find: 'Ophiure noire', 'Petit microcosme', 'Éponges encroûtantes', and 'Mirabelle de mer'. Below the checklist is a section for annotations, showing a photo of a crab with a green bounding box. The central image is an underwater photograph of a rocky seabed with a white grid overlay. A tooltip 'Afficher la grille' is visible near the grid. The bottom of the interface features a footer with the text 'Ifremer | Tous Droits Réservés | Mentions Légales | C.G.U.'

Deep Reef Spy/Espions des récifs profonds

J. Tourolle – BEEP/LEP

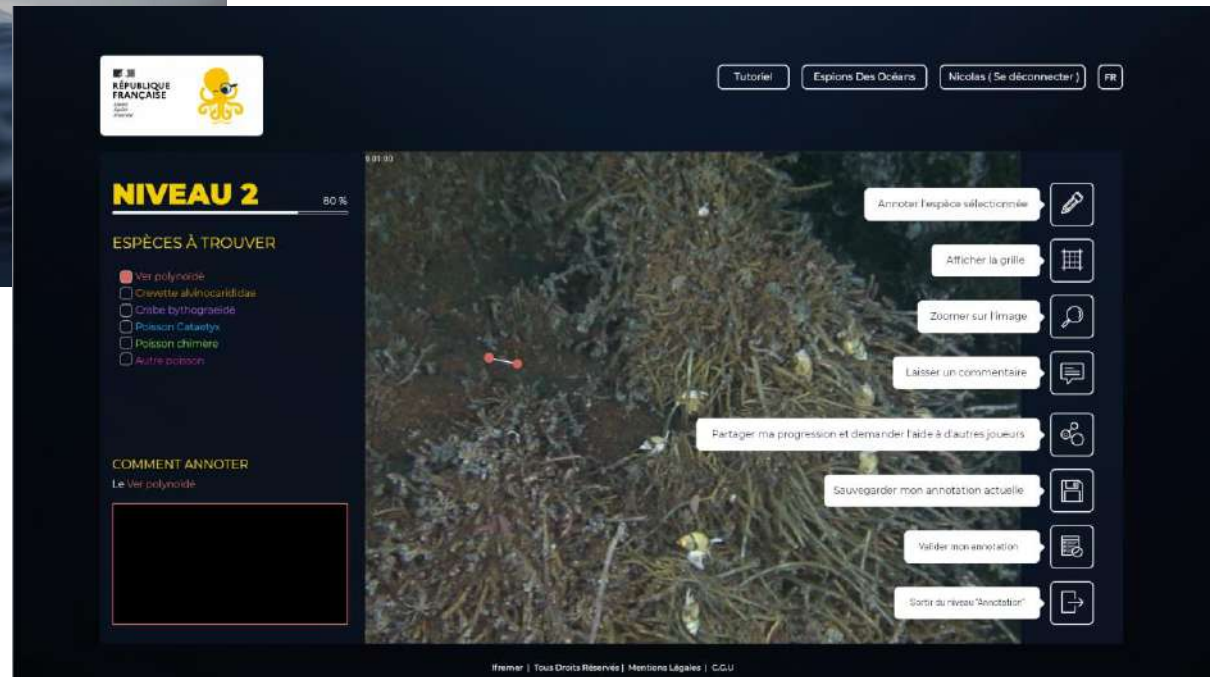


Monitoring of deep coral communities from the Lampaul canyon (Bay of Biscay)

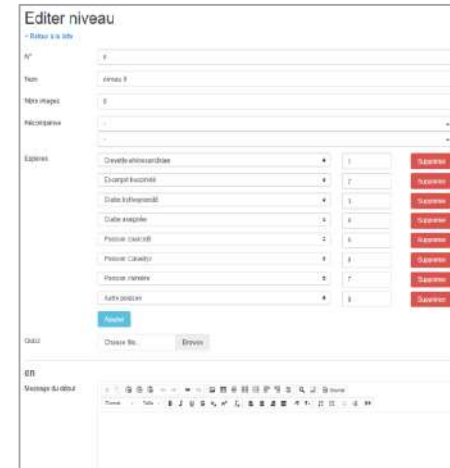
Future images from Marley observatory

Deep Sea Spy/Espions des grands fonds redesign

M. Matabos – BEEP/LEP



- Integration on the Ifremer IT infrastructure
- Development/Finalization of sub-projects
- Administration integration
- New sub-projects (e.g. STAVIRO images)
- New features (e.g. citizen validation)
- Animation and communication around the project
- "Ocean Decade" label



Thank you to...

Yannick Cenatiempo
Nicolas Roullet
Jozée Sarrazin
Pierre-Marie Sarradin
Jean-François Rolin
Olivier Soubigou
Guillaume Clodic

Engineers from ONC and Ifremer

Crews of the RVs Pourquoi Pas?, Thalassa, T.G.
Thompson & J.P. Tully and pilots of the ROVs
Victor 6000 & ROPOS

Yann Lelièvre
Johanna Martin
Patrick Bossard
Thomas Gandarias
Claude Seveno
Réjane Quémeneur
Alicia Cuculière
Antoine Carlier
Pierre-Olivier Liabot

& all the deep sea spys!

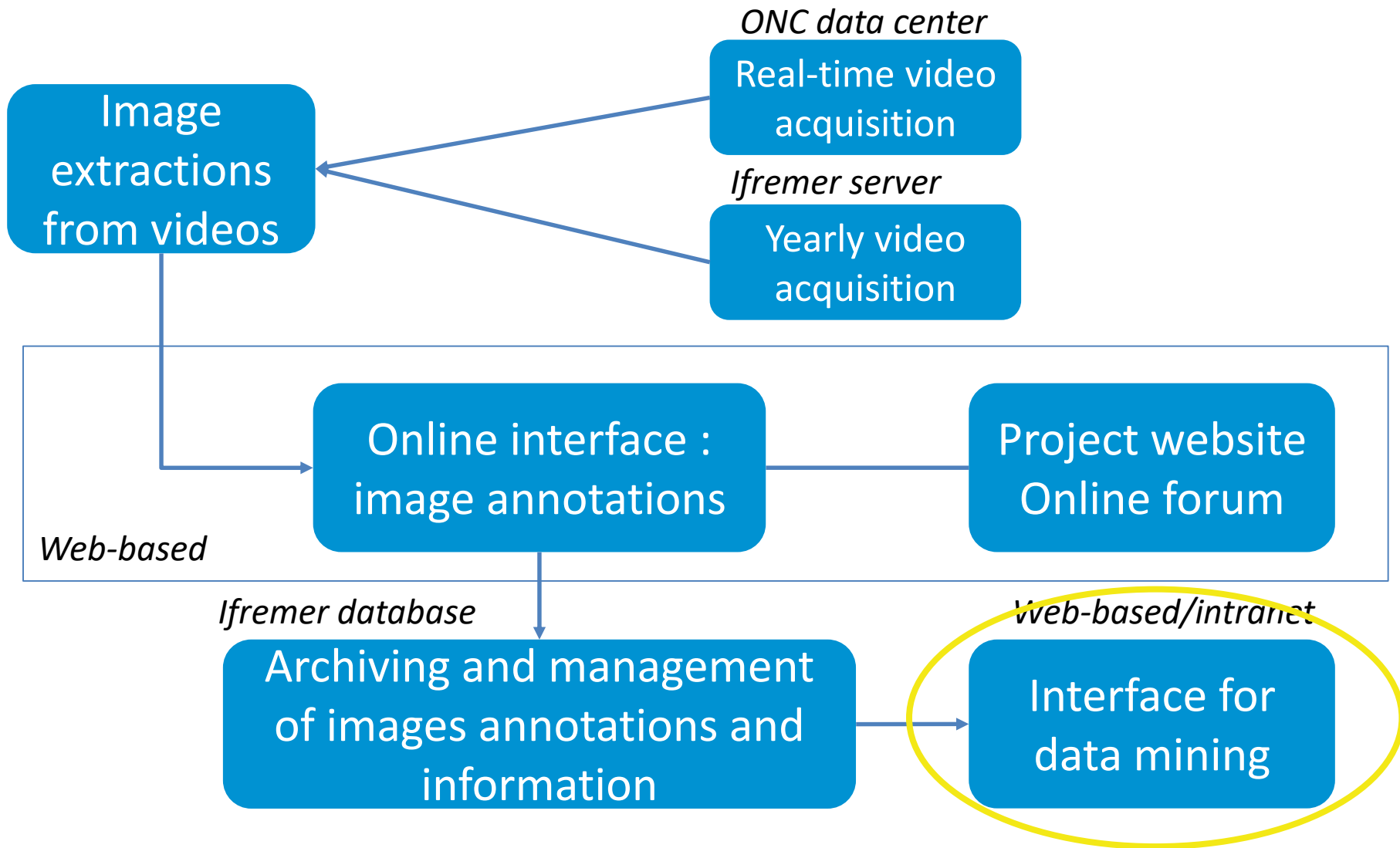
Martin Marzloff
Delphine Binos
Sébastien Rochette
Roland Duffau
Anne-Charlotte Philippe
Clara Ulrich

Thank you for your attention





Development of a citizen science project



A web-based application to search DSS data

Selection :

- Mission
- Observatory
- Time
- Species

* : champ obligatoires

Choisir la/les mission(s) :
Les missions * Toutes les missions

Choisir le/les observatoire(s) :
Liste des Observatoires * Tous les observatoires

Choisir la/les espèce(s) :
Le/Les Taxons disponible *
Crabe bythograeidé
Escargot buccinidé
Poisson zoarcidé
Crabe araignée
Poisson Cataetyx
Poisson chimère
Autre poisson
Ver pdyncidé

Couverture temporelle :
Toute la couverture temporelle de la mission
Debut * DD/MM/YYYY Fin * DD/MM/YYYY
Si fixe :

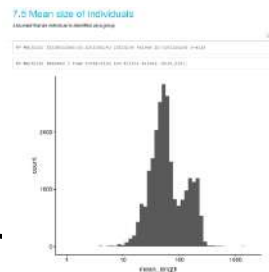
Plage horaire : *
 Tout Fixe Définir une plage horaire

Ne pas échantillonner
Fréquence d'échantillonnage *
 Définir un temps (H, M, S) Semaines Mois
Fenêtre de temps d'échantillonnage
Durée : * HH:MM:SS
Application de la fenêtre *
 Avant Symétrique Après

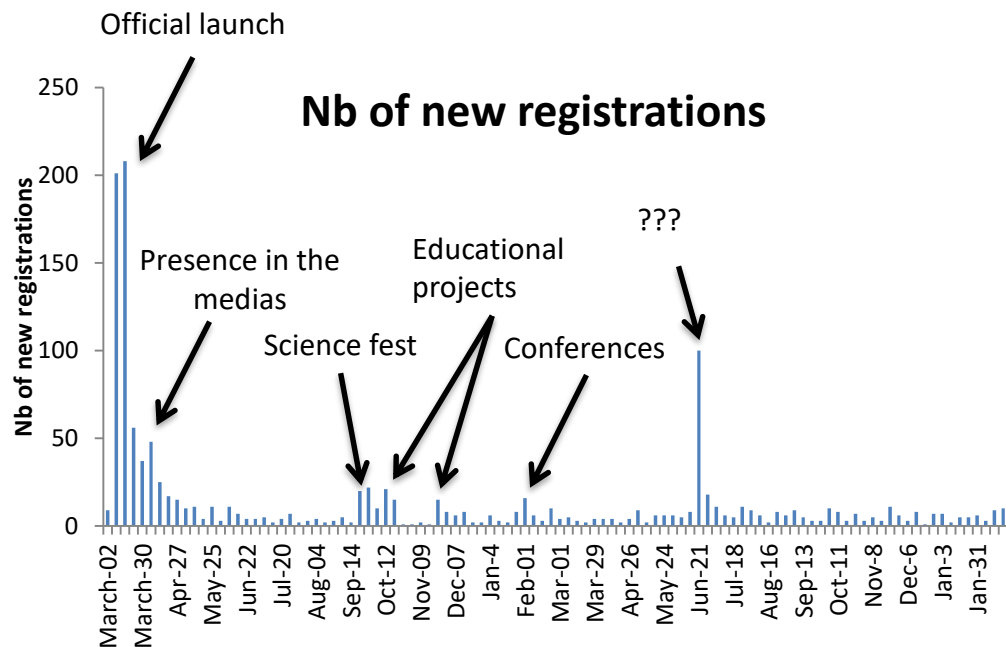
Recherche Mettre à zéro

CSV file export

R import & further statistical analyses

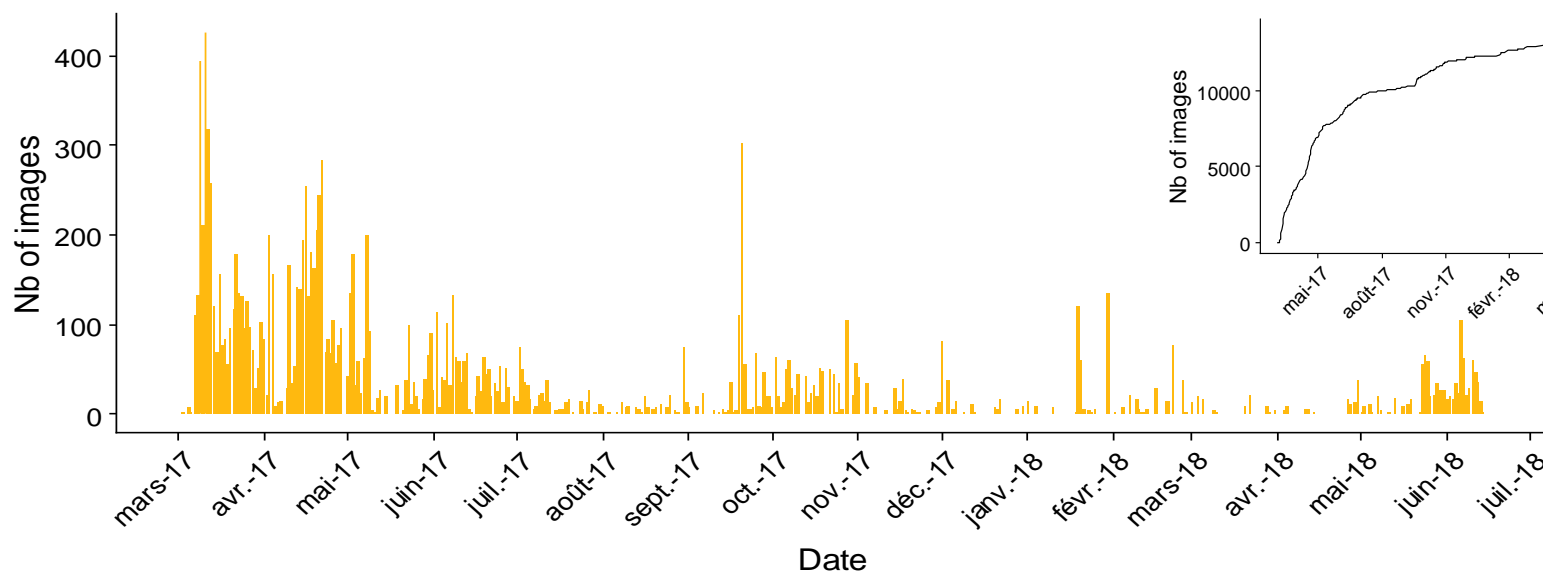


(habitats mapping, ecological studies...)



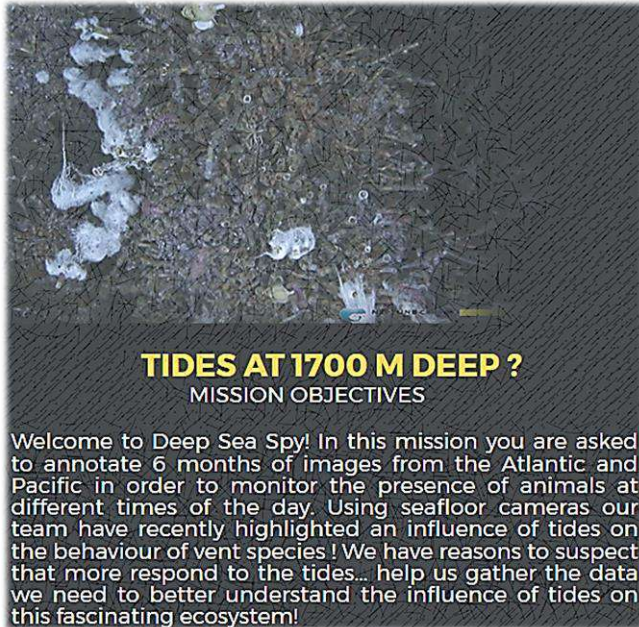
Nb of registered users	1315
Nb of active users (at least one image annotated)	669
> 5 images	384
> 10 images	224
> 100 images	45
> 500 images	8
> 1000 images	5
> 2000 images	1

From 22 countries



Mission: « Tides at 1700 m »

Six months of data: every 6h in the Atlantic and 4h in the Pacific



Nb of **unique image annotated**: 3952

- 3398 from Pacific
- 554 from Atlantic

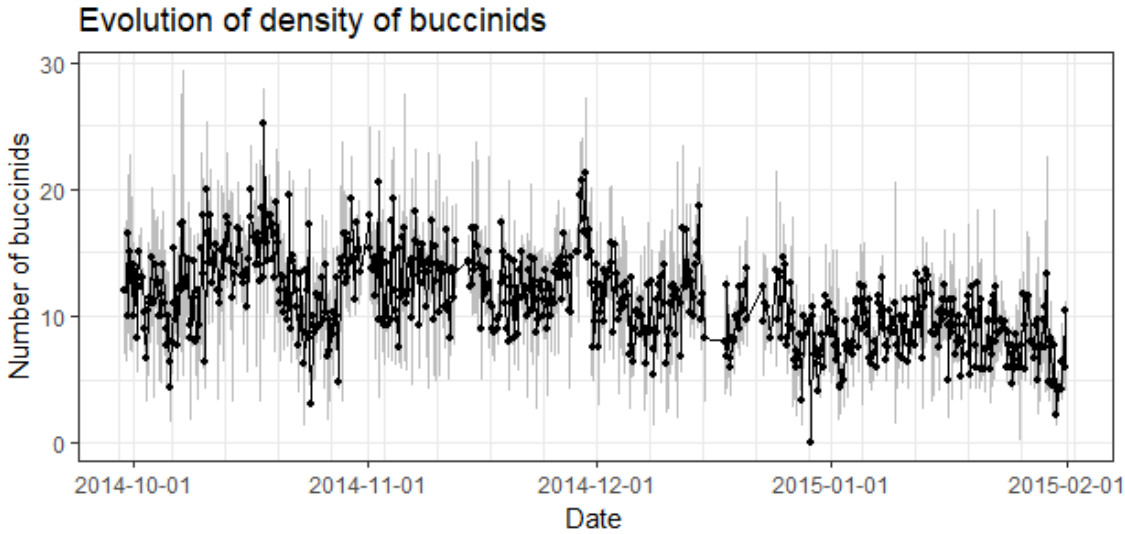
Total nb of **images annotated**: 23177

→ An image is annotated between 5 and 6 times on average

Nb of **participants**: 611

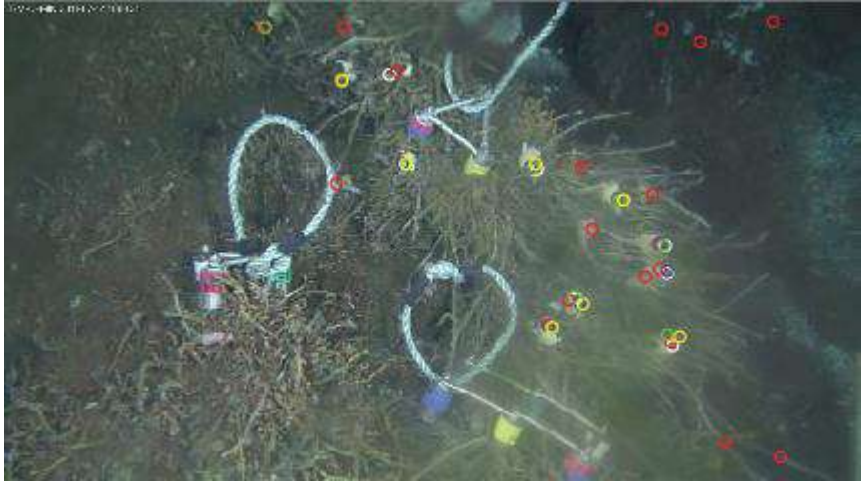
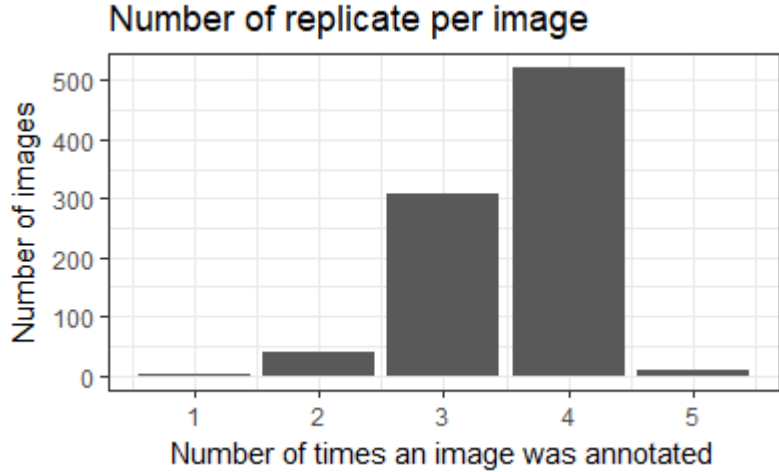
Nb of **annotations**: 188508

Buccinids

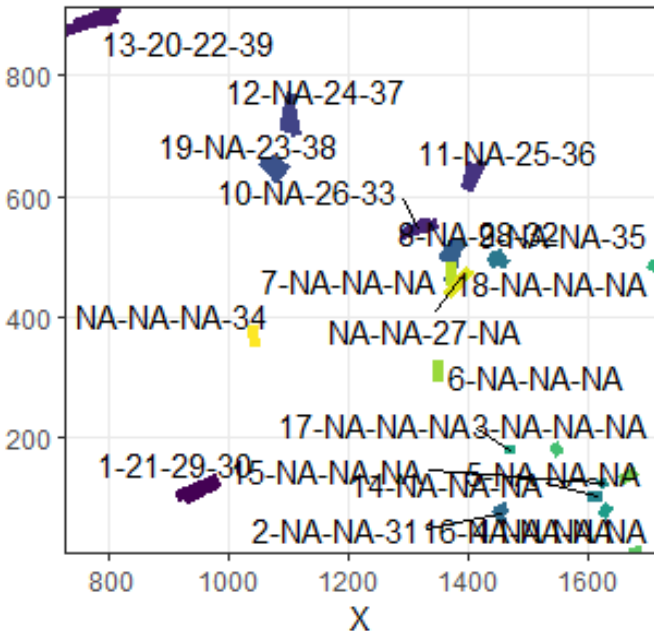
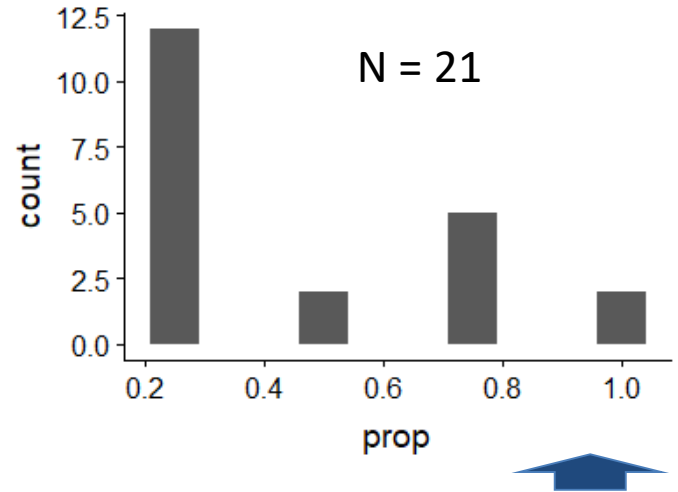
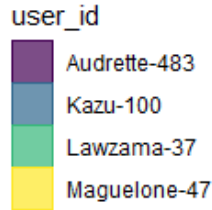
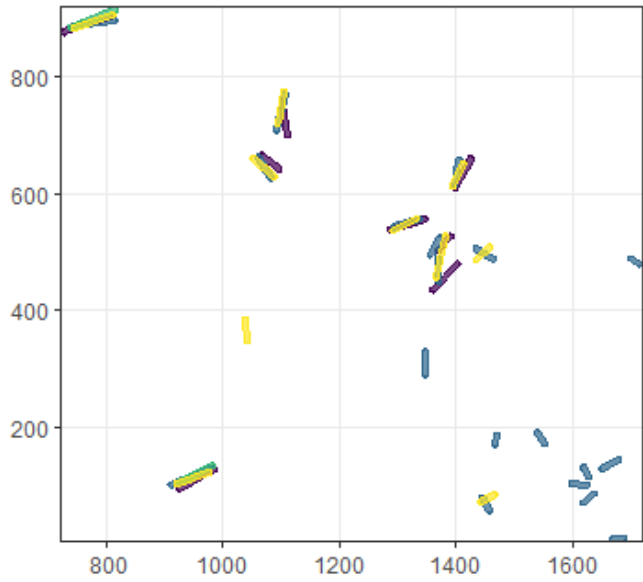


Nb d'annotations: 11,030
Nb d' images uniques: 3,237

- Nb total de buccinidés
- Annotés: 55,041 ind
 - 'vrai': ~ 9,790 ind



Buccinids: multi-participant validation



image_id	group_kept	n	n_user_id	prop	geometry
10681	1-21-29-30	4	4	1.00	list(c(926, 973.837837837838, 94, 119.945945945...
10681	10-NA-26-33	3	4	0.75	list(c(1293, 1308.1061452514, 536, 544.13407821...
10681	11-NA-25-36	3	4	0.75	list(c(1395, 1398.46153846154, 613, 620.3076923...
10681	12-NA-24-37	3	4	0.75	list(c(1112, 1103.37091757387, 700, 753.6920684...
10681	13-20-22-39	4	4	1.00	list(c(806, 768.496644295302, 903, 889.84947267...
10681	14-NA-NA-NA	1	4	0.25	c(1599, 1625, 102, 100)
10681	15-NA-NA-NA	1	4	0.25	c(1620, 1629, 130, 115)
10681	16-NA-NA-NA	1	4	0.25	c(1637, 1620, 85, 70)
10681	17-NA-NA-NA	1	4	0.25	c(1470, 1468, 185, 170)
10681	18-NA-NA-NA	1	4	0.25	c(1715, 1702, 479, 488)
10681	19-NA-23-38	3	4	0.75	list(c(1083, 1073.88397790055, 627, 641.5027624...
10681	2-NA-NA-31	2	4	0.50	list(c(1458, 1447.6, 57, 73.8), c(1447.6, 1445, 73....
10681	3-NA-NA-NA	1	4	0.25	c(1540, 1553, 190, 172)
10681	4-NA-NA-NA	1	4	0.25	c(1688, 1669, 9, 7)
10681	5-NA-NA-NA	1	4	0.25	c(1679, 1652, 143, 128)
10681	6-NA-NA-NA	1	4	0.25	c(1349, 1348, 328, 290)
10681	7-NA-NA-NA	1	4	0.25	c(1370, 1371, 488, 449)
10681	8-NA-28-32	3	4	0.75	list(c(1383, 1380.09090909091, 526, 513.4545454...
10681	9-NA-NA-35	2	4	0.50	list(c(1464, 1447.04657794677, 487, 497.5228136...
10681	NA-NA-27-NA	1	4	0.25	c(1362, 1403, 435, 479)

Oceanopolis,
Computer terminal



© Océanopolis



Science fest
Brest, Quartz, 2016

Devenez un espion des grands fonds

Participez au projet Deep Sea Spy pour aider les scientifiques du laboratoire environnemental Ifremer!

Comment ?
En annotant des images provenant d'observations sous-marines, situées à plus de 1000 mètres de profondeur, il s'agit de sources hydrothermales.

Océanopolis EMSCO/Canaris
Dorade de l'As de Fack, Océan Pacifique

Océanopolis EMSCO/Canaris
Dorade Méditerranée, Océan Atlantique

Depuis 2010, des caméras déployées enregistrent des milliers d'heures de vidéos ! C'est une archive précieuse mais le temps d'analyse dépasse largement la capacité humaine de notre équipe scientifique !

Pourquoi nous avons besoin de votre aide ?

Pour quelles découvertes ?

Analyser la distribution des espèces permet de:
Définir les habitats spécifiques adaptés à chaque espèce en terme de filaire hydrothermale, température, oxygène et autres paramètres.
Révéler l'influence de la merée sur le comportement des vers et des moules.

ENVRI Ifremer

Science fest
Paris, Cité de la science et de l'Industrie, 2017



Ocean fest, Paris, aquarium de la porte Dorée
Ocean Hackaton, Brest
General public conferences...

Immersion sciences (Loctudy)



Educational projects

Training for school teachers (Oceanopolis)

Training for middle and high school teachers (Regional school academy- CSTI)

Young reporters of art and science (Oceanopolis)

Educational days

Educational booklets Cycles 1-2-3 (3-11 years)



- Results allow detection of trends in accordance with previous studies
- High variability among participants
- Spatial analyses will bring additional information and highlight the need for multi-participant data
- Validation processes still to be defined
- Generate a reference dataset for the development of machine learning algorithms
- Share the system with other Ifremer imagery data types (coastal environment, fisheries...)