

FICHE 2/2

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Titre du projet et son acronyme : **Scaled Acoustic Biodiversity - SABIOD**

Mots clefs du projet : bioacoustique, surveillance environnement et biodiversité, passages à l'échelle en durée précision et classes, apprentissage et reconnaissance temps-fréquence, Système distribué en calcul (GPU) et en senseur (Android).

Site Web du projet : <http://sabiody.org>

Rapport et projet Scientifique (fiche 2/2)**TOTAL demandé sur SABIOD 2014 = 61K€**

(nous ne citons que les copublications inter partenaires SABIOD, et non pas les publications mono partenaires)

Nous avons dans la fiche 1 présenté les grandes lignes des résultats et paradigmes scientifiques de SABIOD sur 2012-14. Nous les étendons ici dans la perspectives de deux projets collaboratifs phares sur 2014. Ces deux projets reposent sur les nouvelles avancées en représentation temps fréquence et classification à l'échelle que nous menons dans SABIOD. Il s'agit avec ENS Ulm S.Mallat médaillé CNRS de représentation en Scattering, publiées dans [Glotin,.. Mallat, NIPS4B 2014], avec GIPSA de suivi Temps-fréquence multisource, avec LeCun et LSIS de Bilinear Sparse LPC modeling (travail réalisé durant son séjour invité au LSIS - copub en cours), en Convolutional Neural Net (sur ce point les calculs des modèles sont en cours sur le serveur SABIOD avec la plateforme libre THEANO de l'université de Montréal, spécialisée en calcul à l'échelle sur GPU). Scattering et CNN permettent des représentations temps-fréquences plus rapides en calcul, et optimisées sur les signaux à identifier, de part leur architecture hiérarchique. Ce sont les deux méthodes phares en classification à l'échelle, entraînées sur peu de données étiquetées, ce qui correspond parfaitement au paradigme de SABIOD : nombreuses espèces peu connues à indexer de manière non supervisées. Le clustering à large échelle bioacoustique est le thème du 3ieme workshop international que nous lançons avec Cornell Univ en 2014, et adresse toujours ce paradigme de données peu renseigner à indexer (million de classes).

SABIOD développe aussi des indices synthétiques sur la biodiversité MNHN+LSIS (Lelouch et al 2013). Nous démontrons également dans (Doh, .. , Adam) la puissance du Sparse coding pour la décomposition de sources appliquée à la surveillance de population de cétacés (copub LAM LSIS), et la capacité des modèles de trajectographie à passer à l'échelle en multi-espece et haute fréquence – valorisation brevet (copub Cyberio LSIS). Enfin nous avons travaillé et publié en classification multilabel (copub LIP6 LSIS).

Les perspectives pour 2014 sont bonnes étant donnée la forte cohésion du groupe SABIOD et sa portée internationale, avec des nouveaux challenges internationaux (les plus gros au monde), et en plus des projets développés partie 1, ces deux projet phares, développés pages suivantes en anglais.

1/ LIFECLF

We co-organize with A. Joly INRIA the highest contest on bird song classification (500 species <http://www.imageclef.org/2014/lifeclef/bird> : The task will be focused on bird identification based on different types of 14 K audio records over 500 species from South America centered on Brazil. Additional information includes contextual meta-data (author, date, locality name, comment, quality rates), some spectrogram visual representations and species distributions. The main originality of this data is that it was specifically built through a citizen sciences initiative conducted by Xenocanto, an international social network of amateur and expert ornithologists. This makes the task closer to the conditions of a real-world application: (i) audio records of the same species are coming from distinct birds living in distinct areas (ii) audio records by different users that might not used the same combination of microphones and portable recorders.

2/ SABIOD SUB-PROJECT : TEMPERATE BIRD DAWN CHORUS (PI MNHN)

SABIOD provided a set of training and test recordings for the bird ICML challenge. The training data came from an acoustic sampling done in the Parc Naturel Régional de la Haute Vallée de Chevreuse. The data consisted in 90 mono audio files (150 s, 16 bit, 44.1 kHz) that were obtained at sunrise when birds produce a multi-species chorus. Training data consisted in 35 species specific songs coming from the MNHN sound library.

Then we started with LELOUCH and sparse coding in SABIOD to work on a data set of recordings collected in French Guiana during another project (2011). We first tried several options with sparse coding to track temporally and spatially the bird *Lipaugus vociferans* but no optimal results were obtained. We also started to work on the diversity of sound that can be found at dawn when the acoustic diversity is supposed to be maximal.

We worked on the temporal dynamics of bird dawn choruses that were recorded in Rambouillet during a previous project (2009). This intensive work led to a paper submitted on the 14th of November 2013 to *Methods in Ecology and Evolution*: Monitoring temporal change of bird communities with dissimilarity acoustic indices, by **Laurent Lellouch**, Sandrine Pavoine, Frédéric Jiguet, **Hervé Glotin** and **Jérôme Sueur** (in review).

We collaborated to a research project on global acoustic indices headed by Amandine Gasc (UMR 7205 OSEB). A manuscript is currently in preparation for a submission to *Theoretical Ecology*: Indices of acoustic diversity: analyses of biases and recommendations for uses, by Amandine Gasc, **Laurent Lellouch**, Sandrine Pavoine, Philippe Grandcolas and **Jérôme Sueur** (in preparation)

Therefore, the project 2014 focuses in TROPICAL DAWN CHORUS. Animal acoustic diversity is thought to maximal in tropical forests where animal diversity is extreme. However this acoustic diversity has been rarely, if ever, estimated. To assess and analyse tropical acoustic diversity, we recorded in 2010 the soundscape of the tropical forest localised in **the CNRS Research station Nouragues in French Guiana.**

We obtained a unique audio sampling by deploying a 3D trellis of 24 microphones that recorded the soundscape during night and day. This resulted in a large dataset made of 99,072 files (24 microphones x 4 recordings per hour x 24 hours x 43 days) for a total of 1,634 hours of recording. We first analysed the spatial and temporal heterogeneity of the soundscape using global acoustic indices. This work will be published soon in *Ecological Informatics*. However, this preliminary work only gives a rough description of the complexity of the soundscape and local acoustic diversity. Now, we want to analyse in more details the dawn chorus, a particular short time period when the

acoustic diversity of the forest reaches its maximum. We need to obtain ground truth by scaled classification. Preliminary classification of sound types on a limited set of recordings (25 files for a total of 25 miniatures) showed that the richness is very high (85 sound types inventoried) and that the dynamics are extreme with very few redundancy in sound types between successive days. This suggests a very important acoustic turn-over that needs to be confirmed and estimated for all recording spots and during the whole period of sampling.

We plan to inventory the acoustic diversity of the dawn chorus with R tools currently in development by the team. This work will therefore tackle a unique massive dataset **leading to progress in terms of acoustic diversity knowledge and improvements in sound analysis at large scale**. Tools developed will be available for other large acoustic samples. In particular we would like to estimate the acoustic richness of the chorus, the dynamics of the chorus over days and to test whether the chorus is structured or chaotic. Tools developed will be available for other large acoustic samples.

Long term acoustic monitoring of tropical soundscape project (joint project MNHN-LSIS)

We plan to record in a long term period (time scaling) OVER YEARS in the tropical forest localised in the CNRS Research station Nouragues in French Guiana, first analysed the spatial and temporal heterogeneity of the soundscape using global acoustic indices (<http://www.sciencedirect.com/science/article/pii/S1574954113001271>).

Then we will extend the sampling period should allow us to document (1) year and over-year patterns in the soundscape, (2) to test whether these patterns are correlated with year and over-year weather variations in particular in link with global warming. We will sample over a very long-time period is an important challenge in terms of data acquisition, data storage and data analysis. We will have to develop a recording station that can be autonomous for a very long period without any assistance. The amount of data will also be considerable with an estimation of about 10 To/year. To achieve this, we would need for 2014 :

- 2 weeks field trip to the CNRS Research station Nouragues (French Guiana) for two people (8 k€).
- 12 autonomous digital Wildlife recorders (12 k€)
- Data storage (5 k€)
- Batteries, sd cards, solar panels, PC and other small equipment (5 k€)
- **subtotal required= 30 k€**

3) Subproject “Soundscapes of quiet places” (PI LSIS-CIBRA Italia)

This subproject aims at developing a method to describe the features of quiet natural habitats by analyzing their long-term soundscape. By using autonomous high quality low noise microphones and recorders, the acoustic environment of a selected number of habitats will be recorded continuously for at least 30 days. The goal is to use the acoustic recordings to describe the acoustic richness of the habitats, their signal-to-noise ratio (e.g. their quietness), and to discriminate among different sound categories, mainly geophysical sounds (rain, wind, waters), biological sounds (insects, frogs, birds, mammals), and anthropogenic noises (including distant noise such as car traffic and airplanes).

With spectro-statistical measures it will be possible to separate these sound categories and produce an index of anthropogenic contamination. With the analysis of biological sounds it is then

possible to produce an index of biological richness and diversity; a further analysis layer allows to discriminate and identify the species composing the soundscape.

Habitats to be monitored will be selected according different criteria: the main sites will be chosen to provide a range of acoustical situations ranging from natural habitats with some degree of anthropogenic noise contamination, to habits supposed to be quiet, not contaminated by human noise, e.g. in wild areas, far and well shielded from terrestrial noise sources. To limit the contribute of aerials sources, e.g. airplanes, areas far from main flight corridors will be chosen.

The field tests will include the testing of different types of equipment, some completely autonomous, some with real-time web connection to get continuous feedback.

Already, we built 4 ultrasonic 250 kHz frequency sampling with solar panel on Beagle Board XM * 4 systems, already bought by SATT PACA for LSIS for a valorisation program of the LSIS PATENT = 12 K€, and we got storage (50To) = 5 K€ from SABIOD 2013 credit.

Then for this 2014 project we need :

2 low cost autonomous recording units 4 K€

1 high quality recording unit 3 K€

accessories, solar panels, batteries, PC 3 K€

Placement and recovery of recording units in 5 places in North & Central Italy

10 travels, 1 person 5 K€

Web connected noise monitoring http://www.noisetutor.it/LxT1_1044_SHORTHISTORY.html =5 K€

- subtotal required= 20 k€

This subproject will be cofinanced by Univ. of Pavia: Calibrated noise measure workstation with spectro-statistical analysis = 10 K€

4) Subproject Ultra High Frequency acquisition

The ISM and LMA have built with SABIOD high frequency acquisition system from a Texas Instrument and special devices from LMA. The idea is to measure the impulses received by the ears of a bat after emitting continuous calls with separate pulses when it is in the vicinity of an obstacle. This test bed will help in designing efficient scaled monitoring systems. Other Ultra high frequency systems are developed with Trone and dodotronics. **There are cooperating and do not ask SABIOD credits.**

5) Large submarine observatory ANTARES+NEPTUNE+NEMO (CNPS+LSIS+CIBRA+LAM)

<http://web2.infn.it/smo/index.php>

We now have access to the data with 50 hydrophones sampled at 192k, 24 bits or more in sicilia, Toulon and Victoria Island. **The main problem for this systems is storage**: they can't store everything all the time ... SABIO will in real-time stream of the channels (accurately time stamped AESEBU frames) directly from them, and generate indexes

We need for ANTARES administration 3 K € to join

6) Congress: Ecology and acoustics: emergent properties from community to landscape (MNHN + LSIS)

We organise in 2014 a congress dedicated to the acoustics of large-scale ecological units. This meeting will cover for the very first time topics related to the monitoring of marine and terrestrial acoustic communities and soundscapes. This international event will explore the application of modern acoustic techniques that rely on the acquisition, management, visualization and analysis of big sound data. This event should foster efforts that are individually made in distant laboratories and should lead to a network of researchers that have to face similar technical challenges with large data set..More details can be found at: <http://ecoacoustics.sciencesconf.org/>

Support request: 2 k€

7) Congress: ICML WORKSHOP 2014 (LIP6+LSIS+ENS (Mallat) + FaceBook (LeCun) +Cornell Univ)

We run another international workshop in BEIJING with Cornell univ and other SABIOD partnaire, we request 6K euros

COPUBLICATIONS choisies avec au moins 2 équipes SABIOD

Lellouch L, Pavoine S, Jiguet F, Glotin H, Sueur J - Monitoring temporal change of bird communities with dissimilarity acoustic indices. *Methods in Ecology and Evolution*, in review.

Glotin H., Razik J., Paris S., Adam O., Doh Y. Whale songs classification using sparse coding, in NIPS4B 2013

Olivier DUFOUR - 'ARTIÈRES Thierry - Hervé GLOTIN - Pascale GIRAUDET,"Clusterized Mel Filter Cepstral Coefficients and Support Vector Machines for Bird Song Identification" , The 1st International Workshop onf Machine Learning for Bioacoustics, LSIS, pp. 89-93, ICML 2013, Atlanta, USA, jui 2013 http://sabiody.univ-tln.fr/ICML4B2013_proceedings.pdf

Abeille, Glotin, Giraudet, Pavan, 'Robust Multipulse biosonar decomposition, application to whate biopopulation', submitted to PLOS ONE, in review

Yann DOH - Joseph RAZIK - Sébastien PARIS - Olivier ADAM - Hervé GLOTIN, "Décomposition parcimonieuse des chants de cétacés pour leur suivi" , in : *Traitement du Signal*, Lavoisier, sous presse

Co-Editions liées à SABIOD avec chapitres auteurs SABIOD communs :

Glotin, Artières, Mallat, Lecun et al. 'NIPS for Bioacoustics' Proceedings of int. Workshop NIPS4B, 255 pages, 2013 http://sabiody.org/NIPS4B2013_book.pdf

Glotin, Clark, LeCun et al, 'Int. Conf. Machine Learning ICML, ICML for Bioacoustics, 100p, 2013, http://sabiody.org/ICML4B2013_book.pdf

Adam et al. *Detection Classification Localization of Marine Mammals using Passive Acoustics*, *Dirac* Ed 2013, ISBN 9782746661189

Coédition J.Sueur: <http://www.journals.elsevier.com/ecological-informatics/call-for-papers/monitoring-the-natural-environment-through-sound/>

Glotin et al. *Soundscape Semiotics - Localisation and Categorisation* ISBN 980-953-307-687-9, Ed Intech, feb 2014, <http://www.intechopen.com/welcome/2591f42f72b6e851e6cd65911ec93cb7>

Autres publications majeures :

Xanadu HALKIAS - Hervé GLOTIN - Sébastien PARIS "Classification of Mysticete sounds using machine learning techniques" , in : *Journal of the Acoustical Society of America*, Vol. 134 (5), pp. 3496, nov 2013

Dadouchi F., Gervaise C., Ioana C., Huillery J. and Mars J.I., Automated segmentation of linear time-frequency representation of marine mammal sounds,, 2013. *The Journal of the Acoustical Society of America*, Vol. 134(3), pp 2546-2555.

Modèle d'assimilation du paysage acoustique pour suivre l'état de l'écosystème marin dans le parc naturel marin d'Iroise, Mathias,Delphine and Gervaise,Cedric and Di iorio,Lucia and Mars,Jerome, 3ème congrès international des aires marines protégéesFR 2013-10-21

Sébastien PARIS - Yann DOH - Hervé GLOTIN - Xanadu HALKIAS - Joseph RAZIK, "Physeter catodon localization by sparse coding" , ICML4B in ICML 2013 conference, jui 2013

Régis ABEILLE - Pascale GIRAUDET - Hervé GLOTIN, "Acoustic observations for automatic size estimation of whales" , *Annals of Telecommunications and Radio Science Bulletin*, oct 2013 OCOSS2013