THE GLOBAL TAXONOMY INITIATIVE CAPACITY-BUILDING FOR PARTIES TO THE CBD TO ACHIEVE AICHI BIODIVERSITY TARGETS THAT REQUIRE RAPID SPECIES IDENTIFICATION USING DNA BARCODING FINAL REPORT

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Background

The International Barcode of Life project (iBOL[1]), spearheaded by the Biodiversity Institute of Ontario (BIO) at the University of Guelph (UG), provides a convenient operational framework to help advance international and Canadian obligations under the Convention on Biological Diversity (CBD[2]) and related international framework agreements (e.g., Nagoya Protocol[3]), and to facilitate meeting relevant goals (e.g., Aichi Biodiversity Targets[4]). This is reflected in an ongoing partnership between iBOL and the Secretariat of the Convention on Biological Diversity (SCBD), formalized in an MOU signed in 2010[5]. UG's Prof. Robert Hanner serves as a member of CBD's Global Taxonomy Initiative Coordination Mechanism[6].

BIO has provided Parties to the CBD with information updates on the progress and importance of the global DNA barcoding effort, through participation in meetings and submission of information documents to the meetings of the Subsidiary Body on Scientific, Technical and Technological Advice: SBSTTA-18[7] and SBSTTA-19[8]. The utility of DNA barcoding has gained formal recognition in Paragraph 5(g) of Recommendation XIX/2[9] adopted by SBSTTA-19 (November 4, 2015) that encourages Parties to the CBD "*To support the development, with the assistance, as appropriate, of the international barcode of life network, of DNA sequence-based technology (DNA barcoding) and associated DNA barcode reference libraries for priority taxonomic groups of organisms…*".

As a result of iBOL's active participation in the Convention processes, it has been selected[10] to facilitate the Global Taxonomy Initiative Training Course on Rapid Identification on Invasive Alien Species for Achieving Aichi Biodiversity Target 9 in 2015. Supported by the Government of Japan and the Japan Biodiversity Fund (JBF), it aimed to empower Parties to identify invasive alien species using rapid DNA-based approaches, support capacity building, technology transfer, and information exchange. This was done through a series of training activities that were carried out by the Biodiversity Institute of Ontario, University of Guelph. These activities included online training (through UG's Center of Open Learning[11]) for 22 participants nominated by the CBD Secretariat in March-May 2015, followed by a four-week hands-on training course at the Canadian Centre for DNA Barcoding[12] in July-August, and in October 2015 for 12 selected participants. Participants from qualifying developing countries were funded by the JBF for this training; the participant from a developed country was self-funded. This report highlights the activities undertaken, project deliverables, key outputs and outcomes.

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[1] http://ibol.org

[2] https://www.cbd.int/

[3] https://www.cbd.int/abs/

[4] https://www.cbd.int/sp/targets/

[5] http://ibol.org/ibol-cbd-pledge-to-work-together-towards-common-goals/

[6] https://www.cbd.int/doc/lists/gti-cm.pdf

[7] https://www.cbd.int/doc/meetings/sbstta/sbstta-18/information/sbstta-18-inf-20-en.pdf,

[8] https://www.cbd.int/doc/meetings/sbstta/sbstta-19/information/sbstta-19-inf-19-en.doc

[9] https://www.cbd.int/doc/recommendations/sbstta-19/sbstta-19-rec-02-en.doc

[10] https://www.cbd.int/doc/notifications/2015/ntf-2015-006-gti-en.doc

[11] http://opened.uoguelph.ca/en/index.asp

[12] http://news.uoguelph.ca/2015/08/training-for-developing-nations-aims-to-curb-invasive-alien-species-of-plants-animals/

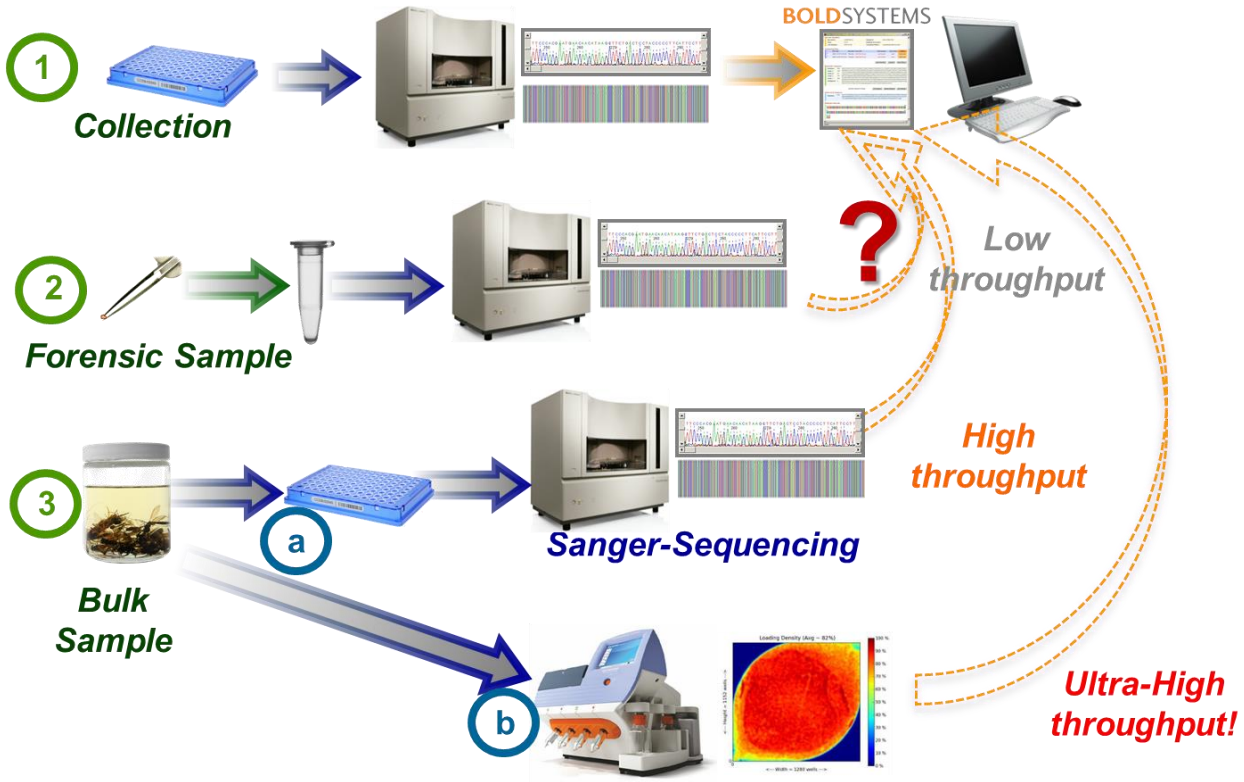

Figure 1. Molecular analytical pathways used to help detect invasive alien species.

A critical step towards achieving Aichi Biodiversity Targets indicated in the Strategic Plan for Biodiversity 2011-2020 (decision X/2) is building the capacity of Parties to utilise rapid and accurate species identification tools. DNA barcoding is a tool for DNA-based species identification and discovery that has proven utility in facilitating the prevention and management of invasive alien species, pests and diseases using standardized molecular diagnostic pathways (Figure 1). The use of a common analytical and diagnostic platform, such as DNA barcoding by the Parties would facilitate networking of experts in invasive alien species identification, coordination of in-situ monitoring, and border control at the national and regional level, as appropriate.

The project provided opportunities for leading academic institutions based in the interested Parties to learn how to fill the technical and scientific needs to implement the CBD, its programmes on invasive alien species and develop capacity to identify priority invasive species in animals, fungi and plants. The activity included selecting 22 appropriate experts who can support Parties' implementation of the Strategic Plan for Biodiversity 2011-2020 to take the distance education course. From those who successfully completed the distance education course, the twelve with the highest scores were invited to take a four-week hands-on training course in standard DNA barcoding methods and protocols in the facilities of the University of Guelph, in Canada. This second course aimed to facilitate the application of this approach at the national or regional levels to manage the introduction or spread of invasive species, including pests and diseases, in order to facilitate achieving Aichi Biodiversity Target 9 on invasive alien species.

The duration of project was from 1 January to 31 December 2015, with a one-month no-cost extension to complete the report.

Project Work Plan

Below is an outline of the project work plan contained in the SSFA between the SCBD and iBOL, in the context of milestones achieved.

Planned activities in the first phase (1 January 2015 – Approx. 31 March 2015)

(a) Evaluation of the coverage, through available rapid identification technologies, of invasive alien species of global priority, which enable their rapid identification for quarantine and bio-surveillance purposes. The DNA barcoding approach was demonstrated to represent an optimal rapid identification technology, with the capacity to be transferrable to developing countries, in particular, least developed countries and small island developing States, as well as countries with economies in transition.

(b) Development of options for enhancing access to, and transfer of, rapid identification technologies and related capacities by competent institutions in developing countries. This was achieved through a combination of specialized online and hands-on training modules.

(c) Identification, on the basis of experience with previous capacity-building activities that were conducted by either iBOL or SCBD, of selection criteria for: (i) participants for a distance education course on methodological approaches and technologies used for rapid detection and identification of invasive alien species; and for (ii) participants for the subsequent hands-on training course on the practical implementation of this technology, taking into account section 2 of decision XII/2 on technical and scientific cooperation. Selection criteria have been developed.

Planned activities in the second phase (1 April 2015 – Approx. 31 December 2015).

(d) Provision of a distance education course on the methodological approaches and technologies used for rapid detection and identification of invasive alien species for experts from at least 20 countries, nominated by Parties to the CBD on the basis of the criteria in (c) above. The courses were open to additional self-funded experts, in order to facilitate implementation of national invasive alien species strategies and action plan as part of National Biodiversity Strategies and Action Plans. Twenty-two trainees have been selected, including one self-funded developed country trainee.

(e) Provision of a follow-up practical training course for at least 10 participants selected from among the participants in the distance education course described in (d) above. This training sought to empower experts to apply this technology and approaches in their home countries. The training was be conducted at a facility where trainees were provides with laboratory bench space, equipment, training instructors and informatics support, as well as accommodation and other logistical support. The applicant was responsible for purchasing of air tickets for the participants.

(f) Provision of post-training support to the participants of the distance education course and the hands-on course to help them apply their knowledge with a view to establishing workflows for rapid detection and identification of invasive alien species in their home institutions and monitoring of progress in application and sharing of the newly acquired technical capacities.

(g) Preparation of a progress report on the outcomes of activities (a) through (f) prior to the twentieth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice.

Activity Number and Event Description	2015											
	January	February	March	April	May	June	July	August	September	October	November	December
1) Request for nominations from GTI Focal Points by SCBD												
2) Review of nominations received by SCBD												
3) Delivery of the online training course for selected candidates												
4) Preparation of the training venue at the University of Guelph												
5) Delivery of the hands-on training course for selected candidates												
6) Post-training follow up and project reporting												

Figure 2. Gantt Chart of project activities.

Report on Project Activities

Activity Timelines

Project activities were carried out in the following stages (Figure 2):

1) Request[13,14] for nominations to Parties to the CBD and their National GTI Focal Points;
2) Review of nominations received and endorsement of candidates for the online course;
3) Selected candidates taking the online course;
4) Evaluation of performance of individual online course participants and nomination for the hands-on training course;
5) Preparation of the hands-on training venue and arrangement of travel logistics for international visitors;
6) Hands-on training course at the Biodiversity Institute of Ontario.

Request for Nominations, Selection of Candidates, and Geographic Representation

Figure 3 illustrates the geographic representation of expressions of interest received from different countries in response to the SCBD's call for nominations and their further involvement in follow-up training activities. Expressions of interest were received from 60 countries, of which 50 submitted formal nominations: Algeria, Bangladesh, Belarus, Bhutan, Botswana, Burkina Faso, Burundi, Cameroon, Colombia, Comoros, Cook Islands, Cote D'Ivoire, Cuba, Dominican

[13] http://www.cbd.int/doc/notifications/2014/ntf-2014-141-gti-en.doc

[14] https://www.cbd.int/doc/notifications/2015/ntf-2015-006-gti-en.doc

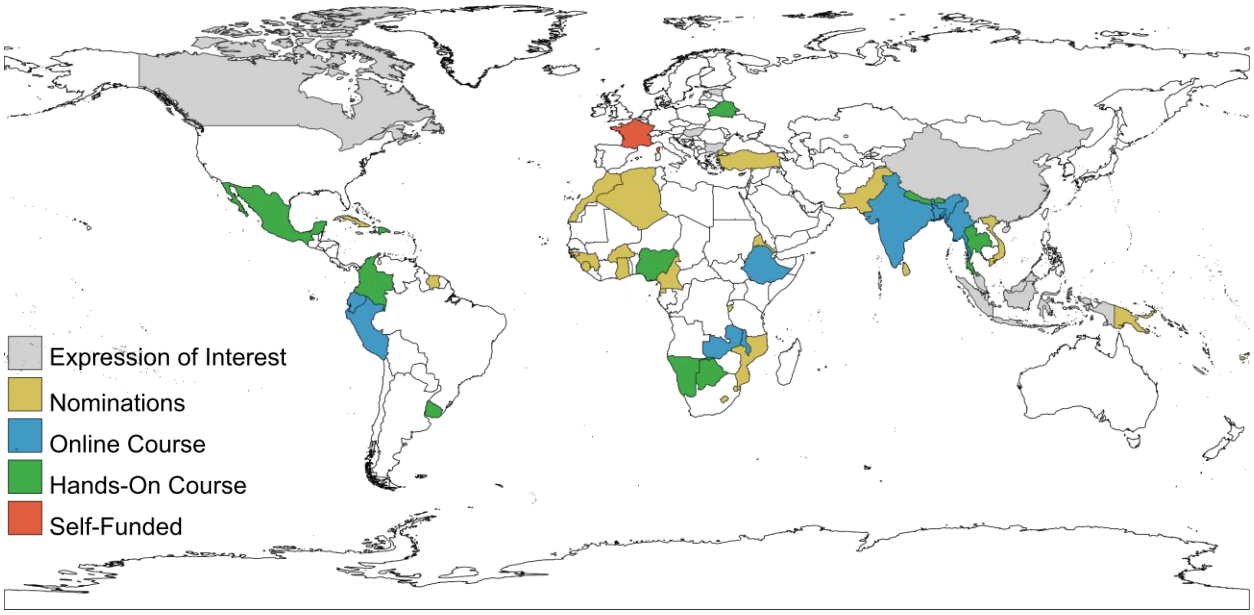

Figure 3. Geographic representation of countries involved in the 2016 CBD-GTI training initiative. Map generated using SimpleMappr (http://www.simplemappr.net).

Republic, Ecuador, Eritrea, Ethiopia, Fiji, France, Ghana, Guinea, Guinea Bissau, India, Jamaica, Kiribati, Lesotho, Malawi, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nigeria, Pakistan, Papua New Guinea, Peru, Sao Tomé, Sierra Leone, Sri Lanka, Suriname, Swaziland, Thailand, The Gambia, Turkey, Uruguay, Vanuatu, Vietnam, and Zambia.

In consultation with the GTI Coordination Mechanism, the SCBD selected 22 participants from 22 countries to participate in the online course, including: Bangladesh, Belarus, Bhutan, Botswana, Colombia, Cote D'Ivoire, Dominican Republic, Ecuador, Ethiopia, France, India, Malawi, Mexico, Myanmar, Namibia, Nepal, Nigeria, Peru, Thailand, Uruguay, Vanuatu and Zambia. BIO facilitated online training through the University of Guelph Center of Open Learning (March 2 – April 24, 2015) for 22 participants from 22 countries as nominated by the CBD Secretariat, including one self-funded participant from France. The participant from Vanuatu had to drop from the course due to technical difficulties caused by damages from a natural disaster, but was able to take the course at a later date. Online training modules were delivered by Dirk Steinke.

Based on the outcome of online training, 11 participants with the highest scores from developing countries (Belarus, Bhutan, Botswana, Colombia, Dominican Republic, Mexico, Namibia, Nepal, Nigeria, Thailand and Uruguay) and one self-funded participant from France were selected by the SCBD to take a practical hands-on course in standard DNA barcoding methods and protocols at the CCDB in July-August (7 participants) and October 2015 (4 participants – next reporting period). The first round of training was held back to back with the 6th International Barcode of Life Conference[15], which allowed trainees to participate in the Conference as well. Following training activities, the BIO staff involved in the instruction have maintained contact with the trainees, responding to their inquiries about setting up DNA barcoding workflows in their

[15] http://dnabarcodes2015.org/

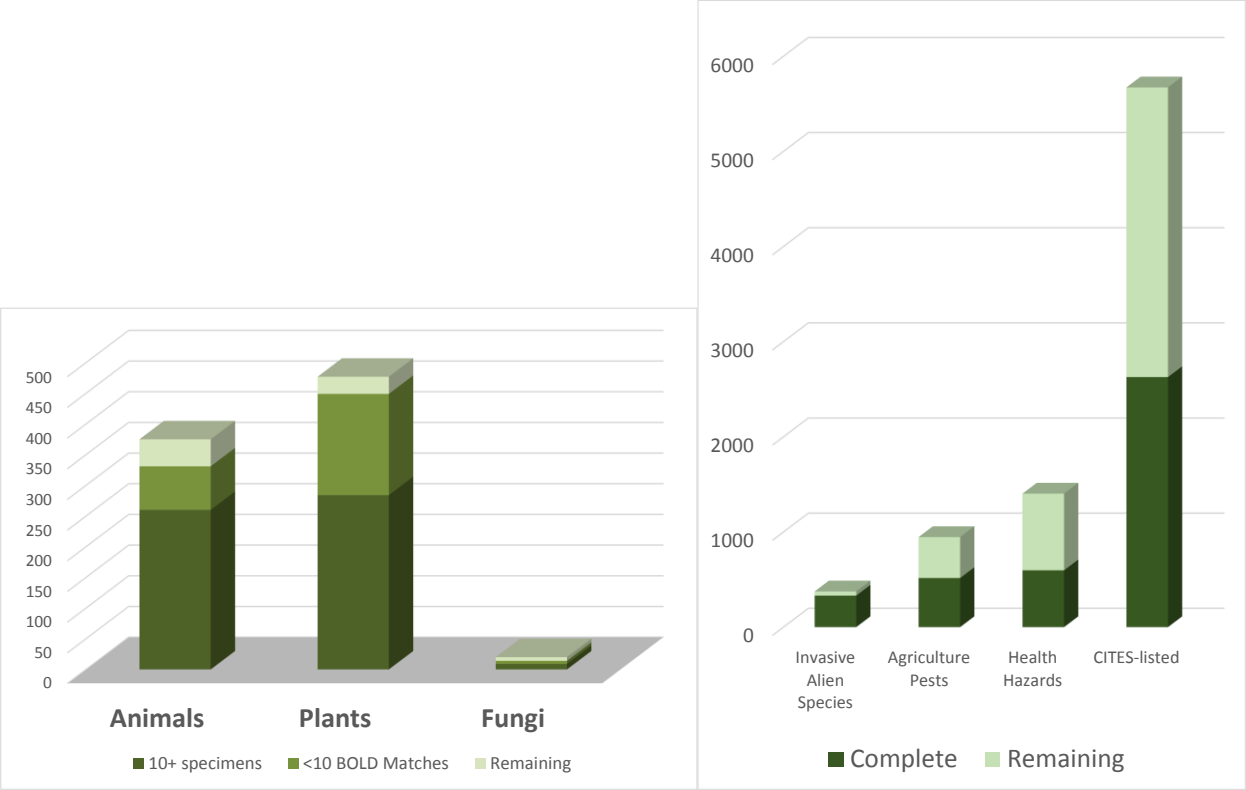

Figure 4. Evaluation of DNA barcode library coverage for IAS (left) and comparison with data on coverage for other priority groups of organisms (right, animals only).

home countries that would improve quarantine detection and management of invasive alien species.

Reports on Project Deliverables

DNA Barcode Coverage for Invasive Alien Species – Deliverable (a)

Alien (exotic, introduced, or non-native) species are generally defined as species that occur outside their natural range in areas that they could not occupy without direct or indirect human involvement. There are 12,122 alien species recorded in Europe alone, and the overall number of species introduced globally is hard to evaluate. Invasive species constitute a subset of alien species that show a tendency to proliferate and spread rapidly and uncontrollably and to cause significant impacts on local and regional ecosystems, resulting or posing threat of ecological and/or economic damage, adversely impacting native biodiversity, often posing health risks to native organisms and/or local human populations, or otherwise adversely affecting ecosystems and human wellbeing. The list of invasive alien species (IAS) is considerably shorter (less than 1000 species) and is maintained by The Global Invasive Alien Species Partnership – an intergovernmental body tasked with helping identify and track invasive species in an effort to aid their management. Molecular methods like DNA barcoding provide a means of facilitating the rapid and accurate identification of invasive species for all users, but, until recently, the extent of their coverage in barcode reference libraries has not been evaluated.

A gap analysis of global invasive alien species coverage in the global reference DNA barcode library was performed by cross-referencing the information contained in the Global Invasive

Species Database[16], kindly provided by Shyama Pagad and Lucilla Carnivali from the IUCN SSC Invasive Species Specialist Group, against the Barcode of Life Data System (BOLD)[17]. Preliminary results (Figure 4) indicate that availability of DNA barcode records for IAS is quite good, especially if viewed in the context of other priority organismal groups, such as quarantine pests, zoonotic disease vectors of zoonotic diseases and CITES-listed species.

As of July 2015, 794 out of 872 species (91%) in GISD have some level of representation in the DNA barcode reference library. The level of detail of provenance annotations and other collateral information varies; for example BOLD records with images constitute 59% for IAS of animals and 74% for plants. By contrast, DNA barcode coverage for quarantine agricultural pests (animals only) is 516 out of 946 species (55%)[18]; whereas the coverage for animals representing human disease vectors and other hazards is 597 out of 1403 species (43%) (Ondrejicka et al., 2014)[19]. The results of this pilot study were presented at the 6th International Barcode of Life Conference in Guelph, Canada (Borisenko et al., 2015)[20]

This signifies that DNA-based diagnostic approaches for IAS are ready for deployment in institutions tasked by the Parties with the responsibility to detect, monitor and manage IAS. Although work remains to be done on closing remaining gaps in taxonomic coverage, as well as improving existing data records and integrating them into national and international reference datasets, this work would be more effective if done in a coordinated fashion, with active participation from all interested Parties.

Options for DNA Barcoding Technology Transfer and Capacity Building in Developing Countries – Deliverable (b)

It is particularly important to ensure active participation of developing countries in the global effort to employ DNA barcoding as a tool for rapid identification and monitoring of IAS, including least developed countries and small island developing states, as well as countries with economies in transition. Discussions held during the hands-on training activities in Guelph involving national IAS experts emphasized that this is an achievable goal and highlighted two important elements that need to be supported:

1) Active information exchange between Parties, including data sharing using existing platforms, such as BOLD, GBIF, GSID, etc.
2) Formation of regional partnerships that include countries where DNA barcoding technology is already deployed, thereby taking advantage of existing regional research and analytical infrastructure, as all Parties attempt to establish and operationalize dedicated DNA barcoding facilities at the national level.

Participant Selection Criteria – Deliverable (c)

The following criteria were developed and suggested to the CBD Secretariat to ensure that training activities had maximum positive impact and that the selection of participants was carried

[16] http://www.issg.org/database/welcome/

[17] http://boldsystems.org

[18] http://plantpestbarcoding.org

[19] Ondrejicka, D.A., S.A. Locke, K. Morey, A.V. Borisenko, and R.H. Hanner. 2014. Status and prospects of DNA barcoding in medically important parasites and vectors. Trends in Parasitology 30: 582–591.

[20] Borisenko, A., J. Shimura, and R. Hanner. 2015. Status report on barcode coverage for invasive alien species. Genome 58: 198–199.

out in a fair and transparent manner, while taking into account the need to maintain balance in representation of different parts of the world and genders.

Participants for the distance education course were selected based on the timeliness and completeness of nominations submitted and the relevance of the professional background of nominees to the mandate of the National Focal Points in meeting Aichi Target 9. The course provided trainees with a solid baseline understanding of the DNA barcoding approach, as it relates to IAS detection and monitoring challenges. The hands on course should perhaps involve people that have infrastructure in place or at least strategies for their implementation. Therefore it was important that trainees would be well positioned within their home institutions to coordinate future development and deployment of the DNA barcoding technology, to engage their colleagues, partners and stakeholders.

Participants for the follow-up hands-on training course were selected by SCBD, in consultation with members of the GTI Coordination Mechanism, from among the successful trainees involved in the online distance education course, taking into account the following criteria:

1) Overall performance score and performance in the individual training modules. All trainees selected for the hands-on course had a passing score over 97%, therefore selection was very competitive.
2) Timeliness in handing in assignments and activity in participation in online discussions. This criterion was used to measure level of engagement. It took into account the need to accommodate for professional commitments of trainees over the 8-week period of the online course, such as field work and other time-sensitive professional obligations. There was strong congruence between trainees' overall activity and timeliness and their performance in the course. Almost all participants invested a substantial amount of their own time into participation.
3) Gender balance. There was no gender bias observed in the level of participation and performance of trainees, therefore this criterion was met with ease.
4) Balance in representation of different parts of the globe. The distribution of participants across continents was relatively well balanced – see map on Figure 3.

Distance Education Course in DNA Barcoding – Deliverable (d)

Distance education training was based on an existing online education course administered through the University of Guelph Center of Open Learning and Educational Support (OpenEd)[21]. Twenty-two people from 22 countries (including one self-funded participant) were signed up for the online course. The list of participants in the online distance education course is provided in the appendix. In addition to the trainees, two representatives from the SCBD (Junko Shimura and Christine Estrada) were provided with observer status which granted them access to the course materials and training modules and allowed them to participate in online discussions with course instructor and trainees.

The online course "Introduction to DNA Barcoding" provided trainees with a basic understanding of DNA-based approaches as a tool for species identification and discovery. It provided trainees with an overview of historical background on species identification approaches, in order to provide context for demonstrating the methodological advancements of DNA barcoding. Core modules contained a compendium of DNA barcoding operational workflows, and concluding modules provided an overview of its applications. The list of the eight course modules follows:

[21] http://dnabarcodingcourses.com/

1) Foundations of DNA Barcoding;
2) Community standards and best practices;
3) DNA Barcode analytics;
4) DNA Barcoding and Taxonomy;
5) Applied DNA Barcoding I (Ecology, Conservation Biology & Evolution);
6) Applied DNA Barcoding II (Food safety, Pests, Human Health, Invasive Species);
7) Applied DNA Barcoding III (Bio-surveillance, Habitat Monitoring);
8) Future trends in DNA Barcoding.

The course units reinforced the trainees' knowledge of the principles of genetics, as required to understand the method and the choice of particular molecular markers as standards for different taxonomic groups. One of the key modules was devoted to informatics tools used in analysis and interpretation of results. Several units showcased the different applications of DNA barcoding, with a focus on socio-economic issues, including detection and monitoring of IAS. Because the methodological approaches to detecting and monitoring IAS are conceptually the same as those used in identification of other species, the course in its entirety was of direct relevance to the overall scope of this training activity.

Course modules were interactive in nature and included online lectures and instruction, group discussions, individual assignments and feedback. During and after each module, trainees were expected to perform the following:

1) Read the course notes and plan how to achieve the learning objectives;
2) Read the assigned pages and watch accompanying presentations/videos;
3) Read and critically review selected publications;
4) Participate in online group discussions;
5) Take an online quiz or work on a written assignment.

The performance of trainees during the course was assessed on a scale of 0-100% through the results of three online quizzes, five written assignments, and by evaluating the level of participation in online discussions. These elements contributed to the final performance score in the following manner:

Online quizzes – 3 × 10% = 30%

Online discussions – 20%

Assignments – 5 × 10 = 50%

At the end of this course, successful trainees were able to:

1) Describe and comprehend the underlying genetic principles behind DNA Barcoding, and understand its potential technical limitations;
2) Identify species by running database queries, using common database platforms and interpret analytical results;
3) Critically evaluate the results of research studies that utilized DNA-based taxonomy;

4) Utilize the skills acquired during the course to make informed decisions about optimal taxon-specific molecular marker choices and laboratory needs;

5) Synthesize knowledge and effectively communicate essential information about DNA barcoding for purposes of preparing grant proposals and interaction with policy makers.

Upon course completion, anonymous feedback was solicited from trainees using online forms administered by the Office of Open Learning. Based on these anonymous reviews, the course received overwhelmingly positive feedback from all participants, with an overall average quality score of 4.79, on a scale of 1 to 5, with 1 being poor and 5 being excellent. A more detailed breakdown of trainee feedback on specific parts of the course is provided in the Appendix.

Hands-on Training Course in DNA Barcoding at the University of Guelph – Deliverable (e)

A total of 12 trainees, including one self-funded participant, attended one-month hands-on course at the Biodiversity Institute of Ontario, University of Guelph. The overall goal of this training activity was to provide trainees with comprehensive background in DNA barcoding, in order to reinforce the theoretical knowledge acquired during the online course and gain practical skills needed to perform all stages of the analytical pipeline, to set up specimen processing pipelines in their home institutions and to become active users and interpreters of online barcode data. Special emphasis was on practical applications of DNA barcoding in diagnostics, detection and monitoring of IAS.

The Key objectives were:

1) Reinforcing and expanding the theoretical knowledge base of the trainees built during the workshop;

2) Providing in-depth practical experience relevant to their future activities in trainees' home countries;

3) Enabling trainees to become active and competent users of DNA barcode data in existing global information portals (e.g., BOLD and GenBank);

4) Encouraging trainees to contribute DNA barcode information on invasive alien species and to share it with the international user community;

5) Empowering the trainees to apply their knowledge and skills in building DNA barcoding capacity in their respective organisations.

Course Delivery Schedule

Three instances of the training course were offered.

Round 1: 20 July – 16 August, 2015. Seven trainees came to take this course:

Belarus - Dr. Tatsiana Lipinskaya (Laboratory of Hydrobiology for the Scientific and Practical Center for Bioresources of the National Academy of Science of Belarus, Minsk, Belarus)

Bhutan - Mr. Kencho Dorji (National Herbarium, National Biodiversity Center, Ministry of Agriculture and Forests, Serbithang, Thimphu, Bhutan)

Colombia - Dr. Mailyn A. Gonzalez (Laboratorio de Genética de la Conservación, Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Bogotá, D.C., Colombia)

Dominican Republic - Dr. David Hernandez-Martich, Scientific Research Director and Collaborator of the DR Ministry of Environment (Universidad Central del Este y Universidad Autonoma de Santo Domingo, Av. Alma Mater, Santo Domingo, Republica Dominicana)

Mexico - Dr. Rafael Ojeda Flores (Universidad Nacional Autonoma de Mexico, Ciudad Universitaria, 04510, Mexico City, Mexico)

Namibia - Ms. Kirsti Nghidinwa, Chief Conservation Scientist (Ministry of Environment and Tourism, Directorate Scientific Services, Windhoek, Namibia)

Nepal - Mr. Sishir Panthi, Assistant Scientific Officer (Department of Plant Resources, Thapathali, Kathmandu, Nepal)

Round 2: 23 August – 5 September, 2015. This round included only one self-funded trainee:

France - Raphaëlle Mouttet, Entomologist (Agence Nationale de Sécurité Sanitaire (ANSES), Maisons-Alfort, France)

Round 3: 5-30 October, 2015. This round included four trainees:

Botswana - Dr. Amogelang Segwagwe (Botswana College of Agriculture, Gaborone, Botswana)

Nigeria - Dr. Jemilat Ibrahim (National Institute for Pharmaceutical Research and Development, Abuja, Nigeria)

Thailand - Dr. Charuwat Taekul (Plant Protection Research and Development Office, Department of Agriculture, Bangkok, Thailand)

Uruguay - Ms. Rosina Segui (Biodiversity Division, Dirección Nacional de Medio Ambiente, Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente, Montevideo, Uruguay)

Training course instructors and staff

Core staff members of the Biodiversity Institute of Ontario (most of them at PhD level) were deployed to oversee and carry out the training process. Overall administration and logistics of the training course were overseen by Dr. Alex Borisenko (BIO director of international programs) who also instructed on protocols for specimen processing, collection management and convened group discussions on policy, data analysis and several other topics. Core modules dealing with molecular analytical protocols, sequence editing and assembly and bioinformatics were delivered by Dr. Muhammad Ashfaq (lead instructor). Dr. Emily Berzitis (training program coordinator) and Ms. Susana Miranda (visitor liaison) oversaw course administrative logistics and helped with training modules. In addition, Dr. Berzitis led the training modules on digital microscopy. Direct oversight and advisory support was provided by Dr. Natalia Ivanova (BIO's lead DNA scientist), who also convened group discussions on new and emerging sequencing technologies. Dr. Suresh Naik (BIO's R&D specialist) provided instructor support in DNA analytical modules.

At least one of the instructors was engaged full time during regular work hours (9:00 am to 5:00 pm Monday through Friday) for the first three weeks of the training period and most of the time in the fourth week when the trainees either worked on individual assignments or were involved in meetings with BIO's key research and staff members.

Outline of training modules

The provisional outline of the training modules is provided in the appendix. Each trainee was provided with a personal copy of the training manual that contained systematized information about the practical training courses. The exact schedule and topics to be covered were determined on a case-by-case basis by the course instructors in agreement, taking into account the state of progress in processing samples and input from the trainees. Also taken into account was the expected specialization of the trainees after their return to their home institutions.

Training Venue

All training activities were held at the Biodiversity Institute of Ontario, University of Guelph, that provided visitors with personal desk space in a dedicated training facility, located in a separate building (University of Guelph Zoology Annex 2) close to The Biodiversity Building, hosting BIO's core analytical facility - the Canadian Centre for DNA Barcoding, and the Centre for Biodiversity Genomics, hosting the Institutes administration, collections and informatics team and infrastructure. This location enabled the trainees to remain engaged in the institute's core operations, while providing a separate space for practicing molecular techniques and working on individual research assignments. Visitors worked either on temporary computer workstations assigned to them or on their personal laptop computers.

Transportation logistics

All transportation (flights and airport shuttle) were arranged by BIO's administrative staff. Whenever possible, cheapest direct flights were booked to Toronto. Ground transportation from Toronto was arranged through Guelph airport shuttle service (Red Car).

Housing logistics

Visitors attending the training course in July-August were housed in the dedicated townhouse unit rented on campus by the Biodiversity Institute of Ontario. Visitors attending the October training course were housed on campus (one person) or in the London House Bed and Breakfast near downtown Guelph which offered a three-room suite with cooking facilities. Guelph city monthly transit passes were purchased for three visitors housed off campus.

University of Guelph visitor requirements

All training visitors received a 'nil-salaried visiting researcher' status with the College of Biological Science at the University of Guelph. The appointments were governed by the by-laws, rules, regulations, policies, procedures and practices of the University of Guelph in effect at the time of training, including those pertaining to research[22]. While the visitors did not receive employment income from the University of Guelph, this appointment granted them with access to the University of Guelph libraries, on-campus computer network, and to purchase a staff membership in the athletic facilities and the University Club. The visitors were enrolled in the University Health Insurance Plan (UHIP) which is mandatory and covers the cost of doctor's visits and hospital services in Ontario[23].

In order to comply with the University's policies on Environmental Health and Safety (EHS)[24], all trainees had to complete the relevant EHS online training modules and to receive individual site-specific safety instruction from BIO's laboratory manager, Constantine Christopoulos. Prior to being admitted into laboratory and collection facilities, visitors received specific safety briefing from core staff responsible for workplace safety instruction at respective laboratory facilities.

Logistics for transfer and analysis of biological materials

Visitors were encouraged to bring specimens involved in their current research projects to process them during the training activities.

The Biodiversity Institute of Ontario is committed to respecting and following Canadian laws, international treaties, institutional policies and general best practices pertaining to intellectual

[22] Refer to the link http://www.uoguelph.ca/policies/ for further information on U of Guelph policies.

[23] Refer to the link http://www.uoguelph.ca/hr/staff-faculty/benefits/uhip for further information on UHIP.

[24] Refer to the link http://www.uoguelph.ca/ehs/ for further information on UG EHS.

property and biological material transfer (including genetic resources) as they relate to international collaboration and cross-border transfer of specimens.

Any materials that were brought for DNA barcoding analysis to Guelph were exported in compliance with international regulations on the trade of endangered species (CITES – if applicable)[25], with the Canadian Food Inspection import requirements[26], and with the Convention on Biological Diversity Nagoya Protocol on Access and Benefit Sharing (ABS)[27]. A Biological Material Transfer Agreement (BMTA)[28] were signed with institutions providing samples for analysis to record their informed consent to provide specimens for DNA barcoding and BIO's commitment to abide by the conditions of materials transfer. All genomic DNA and residual tissue remaining after analyses was repatriated.

At the end of the practical course, trainees received a certificate of accomplishment from BIO.

Post-Workshop Engagement of Training Course Participants – Deliverables (f-h)

At the end of training activities, trainees were asked to fill out feedback anonymous questionnaires (see Appendix for scanned copies). The hands-on course received overwhelmingly positive reviews – most participants found the course to have delivered adequate background and indicated their intention to proceed with adopting DNA barcoding in their home institutions.

Following the hands-on training, the participants exchanged emails with course instructors regarding follow-up activities and prospects for future collaboration.

Several participants provided a written outline of their vision for next steps to be taken to advance DNA barcoding in their countries. It is expected that further discussions in this regard would be facilitated by the online GTI discussion forum[29] organized by the CBD Secretariat.

In order to solicit follow-up input from training course participants in a coordinated fashion, an electronic questionnaire was developed and circulated among them (see Appendix for the Excel template). It is intended to collect trainee input on key aspects related to building national DNA barcoding capacities:

- Endorsement for DNA barcoding from National Focal Point and/or other relevant entities
- Existing Research Infrastructure to perform barcoding activities
- Existing staffing capacity
- Laboratory/facility upgrades to operationalize DNA barcoding workflows
- Requirements for more staff training (names, positions)
- National priority areas of application for DNA-based diagnostics (CBD-GTI and others)
- List of prospective national stakeholders/collaborators/users
- List of prospective regional partnerships (institutions in neighbouring countries)

The results of this survey will be shared with the CBD Secretariat and among the alumni of the training activities.

[25] http://www.cites.org/

[26] http://airs-sari.inspection.gc.ca/Airs_External/Decisions.aspx?lang=1

[27] http://www.cbd.int/abs/

[28] http://ibol.org/wp-content/uploads/2010/07/BIO-CCDB_BMTA_2011-11-01.pdf

[29] https://www.cbd.int/gti/guelph-university-forum/default.shtml