

Darwin Initiative Annual Report

Important note:

To be completed with reference to the Reporting Guidance Notes for Project Leaders – it is expected that this report will be about 10 pages in length – Submission deadline 30 April 2007

Darwin Project Information

Project Ref Number	162/15/020
Project Title	Reducing the Impact of Exotic Aquaculture on Chilean Aquatic Biodiversity
Country(ies)	UK, Chile, Canada, USA, New Zealand
UK Contract Holder Institution	University of Wales Swansea (UWS)
UK Partner Institution(s)	NERC Centre for Ecology & Hydrology, Banchory UK University of Victoria (BC, Canada) US Geological Survey (USA) Oregon State University (USA) Victoria University of Wellington (New Zealand)
Host country Partner Institution(s)	Universidad de Los Lagos (ULA) - Chile
Darwin Grant Value	£193,844
Start/End dates of Project	01 October 2006 / 30 September 2009
Reporting period (1 Apr 200x to 31 Mar 200y) and annual report number (1,2,3..)	01 October 2006 – 30 September 2007 Report 2 (Annual report, 12 months)
Project Leader Name	Dr. Carlos Garcia de Leaniz
Project website	www.biodiversity.cl
Author(s), date	Carlos Garcia de Leaniz, Gonzalo Gajardo, Kyle Young 06 November 2007

1. Project Background

Salmon farming is one of the most buoyant and lucrative business in Chile, capitalizing on a highly valuable export commodity that generates significant revenue. Chile is set to overtake Norway as the world's top salmon producer, and the industry is considered a successful example of the country's commitment to free market, world trade and economic growth. Yet, salmonids are not naturally present in the Southern Hemisphere and constitute a potential threat to indigenous species. Under such a scenario, the Darwin Initiative "Reducing the impact of exotic aquaculture on native aquatic biodiversity" is drawing attention to the potential impacts of salmon farming on Chile's unique aquatic ecosystems, with a view of making the industry more sustainable. The project is based at region X ("Los Lagos"), where most of the salmon farming industry is concentrated and from where it has continued to expand since the 80's. The area (Figure 1) is characterized by a complex hydrology and high aquatic biodiversity, with high levels of endemism. Several of the native aquatic species (from a total of 130) are listed as endangered.

The basic problem the project seeks to address is to evaluate and monitor the interaction of exotic salmonids (accidental escapes from hatcheries and net cages, as well as salmonids deliberately stocked for sport fishing) upon native species, in particular fishes. University of Los Lagos, the host-country institution, has its main campus in Osorno (Lake district – Photo 1), and another in Puerto Montt (Pacific coast). The University's mandate is to attend local problems with creative solutions, and so this project represents a timely contribution to such endeavour.

2. Project Partnerships

The partnership between the UK lead institution (UWS) and the Chilean host partner (ULA) was particularly fruitful during the first year of the project (October 2006-October 2007). It benefited from fluent and frequent email and telephone contacts, in addition to four visits by the UK leader to Chile during the first year. The partnership was also reciprocal in many respects. For example, funds for equipment were entirely allocated to the genetics laboratory in Osorno in order to boost its capacity to meet the project objectives, which are closely related to CBD. Thus, commitments to CBD supported by the project include the assessment (and eventually reduction) of loss of biodiversity in key Andean aquatic ecosystems potentially impacted by the development of exotic aquaculture (CBD's 2010 target). The UK leader was also involved in a number of initiatives designed to strengthen and broaden the partnership with the Chilean hosts partner and their commitment towards CBD. Thus, UWS supported a Leverhulme Fellowship (sadly unsuccessful) by the Chilean project coordinator (Dr. Gajardo) to be hosted at Swansea University in 2008, and which would have involved a program of teaching and research on Sustainable Aquaculture. UWS also applied for a joint Darwin Fellowship with McGill University (Canada) and ULA (see below) and secured the involvement of the Chilean partner in an application to a EU -FP7 Coordinating and Support Action entitled "Collective Research on World Aquaculture Sustainability: Sustainable environmental social and economic world aquaculture production". More recently the UK leader and the Chilean partners applied to NERC for funding under the 'urgency call' to examine the impact of a massive salmonid escape event that took place in Chilean Patagonia last April 2007 (Assessing the impact of a large-scale salmonid invasion on native fish fauna after the Aysén earthquake - Chile). Regretfully, these applications have not been successful. In return, the Chilean project coordinator invited the UK project leader to give a plenary conference at the annual meeting of the Chilean Genetics Society held in Viña del Mar in November (1-5) 2006. Funding for this visit was obtained from the International Genetics Federation (USA) and allowed us to promote the Darwin Initiative to a wide audience of geneticists, university students, and officials in key government positions within the aquaculture, and biodiversity sectors. Chilean officials also participated in a one-day workshop on national planning for biodiversity management, hosted by the local project coordinator, Dr. Gajardo.

This first project workshop ("Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity", Puerto Montt , 17-18 January 2007) benefited from the participation of nearly all the project partners from UK, Canada, and USA, as well as all the main Chilean stakeholders (workshop program and abstracts in www.biodiversity.cl). The work of the local project coordinator Dr. Gonzalo Gajardo, and of the logistics coordinator Dr. Francisco Orellana, were key in securing the active participation of Chilean stakeholders (who were self-funded), and in obtaining additional funding for items not originally contemplated in the budget, such as simultaneous translation, coffee-breaks, etc. The effort done in this respect by officials of Universidad de Los Lagos, and in particular by the Rector of the University (Sr. Aguilar), is greatly appreciated. A similar degree of commitment between partners is also evident in the organization of the Second Workshop (Molecular Ecology of Aquatic Invasions) to be held at Viña del Mar on 17-19 December 2007 (tentative workshop program and abstracts in www.biodiversity.cl), and which is also benefiting from substantial input from ULA, which will cover the travel and accommodation costs of one of the two keynote speakers (Prof John Beardmore). As in previous occasions, key Chilean government officials from CONAMA (National Commission for the Environment) will participate in the Second Workshop, as well as a panel of national and international speakers, who will include researchers from Argentina, where there is also growing concern about the rapid spread of invasive salmonids. This will no doubt help to disseminate the project and will likely result in new interactions.

Other activities that are helping to strengthen our partnership include a proposal (led by Dr. Guillermo Giannico, Oregon State University, USA) to host an international workshop on reducing the impacts of salmon farming on biodiversity at the 2008 IUCN World Conservation Congress in Barcelona (**Annex 4**), as well as a grant application by Dr. John Volpe (U. Victoria) to the Canadian Research Council to examine the impact of salmon escapes in British Columbia and Chile. The outcomes of these are still pending. On the negative side, we must mention the recent withdrawal from the project of the ULA-Pto. Montt partner (Dr. Francisco Orellana) due to other commitments, and of one of our sponsors (Marine

Harvest Chile) due to recent changes in the management of the company. We have reacted to these challenges by strengthening our relationship with I-Mar at Pto Montt (where one of our researchers, Kyle Young is based) through its Director (Dr. Alejandro Buschmann), and by seeking ways to persuade Marine Harvest Chile to continue supporting our project through contacts with the parent company in Europe. In addition, we have continued to make extensive contacts with stakeholders, either seeking cooperation from industry or in relation to the preparation of the Second workshop. For example, the local host coordinator was invited by Dr. Roberto Neira (who leads Aqua-Innovo, a consortium co-funded by the salmon industry and government) to attend a meeting aimed at discussing a Salmon genome project in Chile. The meeting was attended by academics from several universities, as well as by representatives of government funding agencies (Conicyt, Corfo, Fondef) and FONDEF, a funding agency promoting the relationship between industry and University.

Other Collaborations

Professor Ian Fleming (Director of Ocean Sciences Centre, Memorial University of Newfoundland, Canada; <http://www.mun.ca/osc/ifleming/index.php>) kindly agreed to become the project's external advisor and to provide the keynote lecture during the First International Darwin Workshop. Likewise, Dr. Eric Verspoor (Head of Conservation and Restoration Group, FRS Freshwater Laboratory, Scotland) has agreed to become our keynote speaker in the Second Workshop, and to help us with the training component on Genetic Stock Identification.

Important links were also forged with national and international groups during the First Workshop, and thereafter. Thus, Dr. Günter Försterra and the Director of Fundacion Huinay (Dr. Vreni Häussermann) invited the project partners to carry out field work at the Huinay field station (where large numbers of exotic salmonids were recorded and filmed underwater in the local river by Dr. John Volpe, the Canadian project partner). Plans were also made between the UK partner and Fundacion Huinay for Aquaculture MSc placements (see below). Meetings have also been held with WWF-Chile, as well as with other NGO's (sport and professional fishermen), government agencies (CONAMA, SubPesca), and representatives of the salmon farming industry, including INTESAL (the salmon association), Marine Harvest, and salmones Multi-Export. Collaborations were developed with Dr Evelyn Habitt (Universidad de Concepcion, Chile) who agreed to participate in the workshop and to chair one of the sessions, with Dr. Brendan Gara (Falkland Islands) and with Cristian Correa, a Chilean PhD student. Thus an application for a Darwin Fellowship was submitted with Cristian Correa with support from McGill University (Canada), and a Darwin Scoping Award was submitted in collaboration with Dr. Gara to examine interactions between introduced salmonids and endemic galaxiid fishes in the Falklands Islands. The Darwin Scoping Award application was successful, and a field trip was made by UK staff to the Falklands last August 2007, which led to the development of a full Darwin application to be submitted on the next call for proposals. Collaborations developed through the Darwin Initiative between UWS-ULA and the Falklands contacts have been extremely fruitful, and resulted in a MSc thesis (Ben Perry) on the impact of invasive salmonids on native galaxiids, jointly supervised by UWS, ULA and Falklands & Islands Development Corporation staff, as well as plans for future collaborations. The summary and conclusions of this thesis have been uploaded into the project webpage, and are presented in Annex 5.

3. Project progress

The key activity milestone for year 1 was the development of a suitable sampling program and the molecular & isotopic toolkits.

3.1 Progress in carrying out project activities

Activity 1. Research & monitoring of exotic and naturalized fish species, in relation to **Output 1** (Assessment of abundance, distribution, and impact of exotic and naturalized salmonids). The activity milestones for year 1 were to develop and field test diagnostic methods for species identification, stock assignment and trophic niche overlap, and begin screening of fish. Progress during the first year on this activity was adequate, but slower than expected due to delays in the recruitment of suitably qualified personnel, shipment of vital equipment, and - more recently- loss of tissue samples during air transport.

We initiated the 2007 field season with two primary goals: (1) to assess whether methods used to determine the presence/absence and relative abundance of fish species in hydrologically similar regions of North American were transferable to Chilean Patagonia, and (2) to establish and conduct initial 'baseline' surveys of sites for long-term monitoring in the Aysén River basin, the location of the southernmost concentration of salmonid farming in Patagonia. With help from all partners during the January workshop, a sampling field protocol involving a combination of snorkeling and electro-fishing was agreed, and protocols for collecting samples and carrying out mtDNA and microsatellite analysis were transferred from U. Wales Swansea to U. Los Lagos.

The agreed target for the project was to survey a total of c. 80 marine and freshwater sites for the presence of exotic and naturalized salmonids, and to sample 12 aquaculture facilities (8 in the sea and 4 in freshwater) for baseline data on genetic variation and isotopic signatures of two main farmed species, Atlantic salmon (*Salmo salar*) and rainbow trout (*Oncorhynchus mykiss*). Distribution data and samples of brown trout (*Salmo trutta*) and native galaxiids would also be recorded whenever possible. Initial results from the first months of work were reported in the half-yearly report.

As the field season progressed, additional goals were set, in line with the logical framework and the project objectives, namely : (1) to determine the frequency with which escapes from marine aquaculture facilities enter coastal rivers; (2) to locate study sites appropriate for long-term monitoring and/or intensive study of the impacts of aquaculture-driven invasions on native freshwater fishes; and (3) to collect specimens and tissue samples of rare native fish for genetic analysis. To this end we sampled 74 sites in 46 rivers using a combination of downstream day swims (4 rivers), upstream night swims (14 rivers), and electro-fishing (28 rivers). For each site we recorded the latitude and longitude, and a summary description of physical habitat, the accuracy of which depends on the length of the survey, which varied from < 100 m to 8 km. These data provide novel information on the presence-absence and relative abundance of native and exotic species, the reliability of which depends on the size of the rivers and the method of survey. We found exotic salmonids in all rivers surveyed, and in many cases these were the only fish present. In stark contrast, in no case did we encounter only native fish species, which were always found in sympatry with salmonids.

Road access allowed us to survey 19 rivers beginning from where they entered the ocean (50-400 m). Of these, aquaculture farm escapes were captured in 11 rivers (58% of cases), 9 of which had rainbow trout (*Oncorhynchus mykiss*) and 6 of which had Atlantic salmon (*Salmo salar*). For every escapee we captured we collected scales and tissues for genetic, isotopic and life history analyses, and examined their stomachs for diet analysis. Analysis of gut contents revealed that 27 of 38 rainbow trout (71%) and 5 of 13 Atlantic salmon escapees (38%) had clearly consumed freshwater prey. These results provide the first evidence demonstrating freshwater foraging by farm escapes in Chile , and suggest that escapees have the potential to affect native freshwater fish and macroinvertebrate communities without the need to reproduce. Though these rivers were surveyed only once, making absence data unreliable, our general impression is that if there is an aquaculture facility within view of the river mouth, there will be escapees in the river.

From our surveys, we can highlight three systems for pilot studies of interactions between aquaculture, exotic salmonids and native fish.

Rio Camanchaca is 8 m. wide and has a steep (10-15 %), uniform, boulder-cobble channel draining directly into the ocean less than 400 m from a large aquaculture facility. We electro-fished all holding habitats in this stream from the mouth up 300 m in three sections (70, 60, 170 m). The biomass of salmonid escapees/wild trout (expressed as g. of biomass per minute of active fishing effort) in the three sections was the following: 90/40, 153/46, and 0/112. The doubling of wild trout biomass in the absence of salmonid escapees suggests an immediate ecological impact of escapees on riverine fish communities. Only a single native fish was captured, and although this may suggest past interference competition with exotic salmonids, it is impossible to determine the impact of escapees on native species.

Rio Huenocoihue is a low gradient (1-3%), third order stream draining directly into a protected bay. Two hundred and fifty metres above the river mouth is an Atlantic salmon smolt hatchery, which draws

water from an impassable dam. We electro-fished all holding habitats from the mouth to the dam, as well as a 100 metre section above the dam. From the mouth to the dam, the ratio of Atlantic salmon escapees to naturalized rainbow trout juveniles was 112:6. Above the dam that ratio was 0:25, again suggesting an impact of aquaculture escapees on naturalized salmonids. Furthermore, the density of the native puye chico (*Galaxias maculatus*) decreased gradually from the mouth to the dam, mirroring an opposite trend in the abundance of juvenile salmon. Taken together, these two pilot studies indicate that aquaculture escapees can have significant effects on native and naturalized fish communities. They also suggest that manipulating the densities of escapees, naturalized, and native fish may provide a useful strategy for assessing the numerical impact of aquaculture on native freshwater fishes.

In a final study conducted during the Austral winter with the help of a MSc student (Ben Perry; **Annex 5**), we used field surveys to investigate interspecific interactions between native fish and juvenile salmonids in three rivers draining into Lago Llanquihue. Here, brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) found in sympatry with native galaxiids constituted 76% of the total fish biomass. The relative abundance of salmonids increased significantly with distance from the river mouth, and their abundance was negatively correlated to that of native fish (*Galaxias plateii* -Puye grande, *Galaxias maculatus* - Puye chico, and *Trichomycterus aerolatus*). Analysis of resource overlap suggested that rainbow trout and puye grande competed for the same habitats and prey items, though the niche of rainbow trout was wider, and thus more generalist than that of puye grande. No evidence was found of predation by salmonids on native galaxiids, though the salmonids examined were mostly small (< 250 mm).

In addition to the collection of salmonid samples, and to begin building a genetic library of native Chilean fishes, we collected tissue samples from 7 populations of *Galaxias maculatus*, 4 populations of *Galaxias platei*, 4 populations of *Trichomycterus areolatus*, 3 populations of *Geotria australis*, 2 populations of *Aplochiton zebra*, 1 population of *Brachygalaxias bullocki*, and 1 population of *Percichthys trucha*.

All data on fish samples, sampling sites, and fish farms were entered in cross-referenced databases.

Activity 2. Capacity building and training in assessing impact of exotic invasions in relation to **Output 2** (Development of monitoring and impact assessment programme with trained personnel). The activity milestones for year 1 were to have initial meetings with stakeholders, to develop GIS database, molecular and isotopic diagnostic toolkits, run training workshops, and establish sampling strategy and field protocols. Progress on this activity was generally very satisfactory. Planning visit by UK staff to Chile was completed ahead of time, in August 2006 and a Memorandum of Agreement was written and signed thereafter. Job positions were advertised in national and international venues, and several candidates were shortlisted and interviewed by the UK leader and Chilean host partner, either in person or via telephone. The two research positions are now in place (Dr. Kyle Young- Evolutionary Ecology of Salmonid Invasions; Sr. Carlos Flores - Molecular Methods). Equipment was ordered and most was purchased and received during the first 6 months of the project. The ULA Genetics & Aquaculture laboratory was remodeled by the University of Los Lagos, and after the purchase of the new equipment with the Darwin Initiative is now fully operational to carry the molecular analyses (see **Annex 3**). Development of GIS database is in progress, and development of molecular protocols was completed.

A network of sampling stations for monitoring the impact of exotic salmonids was identified, and relevant sampling permission were sought from Government . Testing of the toolkit for molecular stock identification is in progress. So far we have processed around 700 individuals at various stages: extraction of genomic DNA, 702 fish; PCR microsatellites, 288 fish; fragment analysis, 192 fish. A panel of twelve microsatellites were transferred from the UK staff to ULA, and these proved successful for Atlantic salmon, whilst a panel of four microsatellites were optimized in Chile and gave good results in rainbow trout. Hence, after a relatively short time of standardization of protocols for a completely novel and initially time-consuming technique for the local laboratory, the expertise required for processing samples (as well as to continue the genetic monitoring in the future) is ready. Frequent contacts by email, telephone and also in person between the laboratory staff appointed in Osorno (Carlos Flores) and Dr. Sonia Consuegra at UWS has permitted to overcome some initial technical difficulties and has greatly aided in the transfer of technologies and in capacity building.

The first training workshop took place during 16-19 January 2007 at Pto Montt with the participation of 12 students, all stakeholders, and nearly all partners. This ended with a joint declaration of intent endorsed by all stakeholders (see point 11 below and www.biodiversity.cl). We originally planned to train in the field two volunteers over the first season. Jane McDonald, an ecologist on leave from the Australian Museum in Sydney, and Andrea Masuero, a Chilean marine biologist were shortlisted for field training. Unfortunately, a week before her training was to begin, Andrea Masuero accepted a permanent position with the Chilean government and withdrew her application. During Jane's first week, Dr. Kyle Young assigned her relevant reading and conducted informal tutorials on fish identification and behaviour, stream ecology, fluvial geomorphology, and watershed processes. Once in the field, Dr. Young spent the first week teaching Jane how to quantitatively describe stream habitat at the 'unit' scale (e.g. riffle, pool, etc.), how to record the fish community in such a site using night-time snorkel surveys, and how to estimate the relative abundance of adult salmonids at the 'reach' scale (4-10 km) using day-time downriver swims in larger channels. Though it takes years to 'master' each of these methods, Jane's learnt quickly and within a week she was able to describe the habitats, read a river and accurately identify and count fish. Jane's subsequent assistance with fish sampling and surveying of the rivers was invaluable in securing data during the difficult first months of the project.

During July 2007, Dr. Kyle Young and Jane McDonald provided field training to Ben Perry, a MSc student from Swansea University who came to Chile and later to the Falklands to help with the sampling and to collected data for his MSc dissertation. Ben's transport and accommodation costs were supported by Falklands Islands Development Corporation as well as by UWS and ULA. Jane MacDonald left in September 2007 to work on Amazon dolphins in Brasil, and was replaced in early October 2007 by two French volunteers, Alexandre Terreau and Anne-Flore Thailly, who had experience with exotic salmonids in the S. Hemisphere (Kerguelen Island, French sub-Antarctic territory). At the Osorno laboratory, the local host coordinator Dr. Gajardo, provided practical training on molecular protocols to four Chilean students: Amilcar Arriagada, an undergraduate student from Catholic University (Valparaiso); Michael Veimann, a final year student from the German School (Osorno); Héctor Venegas, an undergraduate student of aquaculture at University Los Lagos (Osorno); and Soledad Cortez, a PhD student from University Austral who is willing to do her thesis on genetic variation on galaxiid fishes in the laboratory, after her qualification exam. Details of these and other training activities provided by each partner are given in **Annex 4**.

Work in the next period will involve further training of personnel and recruitment of additional volunteers/students. Opportunities for student placements and volunteer are advertised in our webpage, in EvolDir, and also in flyers distributed in several Chilean Institutions and Universities (**Annex 3**). For example, a 3rd year Biological Sciences Chilean student, Patricio Andrés Valenzuela Celis from Universidad Católica de Chile has already expressed interest in working as volunteer beginning next December 2007 (when our two current field volunteers will likely finish their stay with us).

Activity 3. *Education programme and dissemination of results* in relation to **Output 4** (Educational events and media coverage for local people, fish farmers, and rest of stakeholders). The activity milestones for year 1 were to develop an education programme, to establish a project website, and to attract media interest. Progress on this activity during the first year of the project can also be considered satisfactory. All major stakeholders actively participated in the first workshop and the joint statement was publicized via the webpage and the media. The Darwin project was publicized at conferences and seminars and featured in several media events. Initial press releases were produced by University of Wales Swansea and Universidad de Los Lagos, a newsletter article was published in the Darwin Newsletter July 2007 issue

(http://www.darwin.gov.uk/downloads/newsletters/DARWIN_NEWS_9.pdf), and a contribution sent to the Darwin Secretariat which is expected to appear in the forthcoming Tenth Darwin Annual Report. A project website (www.biodiversity.cl), initially in English and later also in Spanish was developed and launched on time for the first project workshop, and this is regularly updated and linked to all partners, stakeholders and sponsors. Dissemination material (flyers, fact sheets) was produced and distributed during the first workshop and also at conferences and seminars. A powerpoint slide show outlining the

background, aims and methodology of project was developed and presented at several Aquaculture seminars in Chile, UK, and Spain.

One manuscript was sent for publication (A.H. Buschmann, F. Cabello, **K. Young**, J. Carvajal & M.C. Hernández-González. Salmon farming in Chile and organic aquaculture standards: regulations, environmental impacts and bioremediation systems. National Organic Standards Board (USA), Proceedings of the Organic Aquaculture Symposium, Washington D.C., Nov. 2007), and two are in preparation. We took advantage of a local controversy in relation to budget cuts in Chile to write a letter to the editor of 'El Mercurio' (one of the main Chilean newspapers) defending the need for basic science and highlighting the Darwin Project as an example of a multidisciplinary and multinational collaboration for sustainable use of aquatic resources. The article was posted in the blog of the newspaper on 22 October 2007 (http://cyt.elmercurio.com/archives/2007/10/ciencia_basica.asp).

During the first year of the project we gave 21 presentations at local, national, and international conferences and/or seminars in relation to the project (full details in **Annex 4**):

G. Gajardo (ULA, Chile)

17/01/2007. 1st International Workshop Reducing the Impact of Exotic Aquaculture, PM, Chile
07/2007. University Los Lagos. Two lectures, Master programme in Natural Resources
05-06/2007. University La Frontera, several lectures, PhD Science of Natural Resources.

Kyle A. Young (ULA, Chile)

17/01/2007. 1st International Workshop Reducing the Impact of Exotic Aquaculture, PM, Chile
06/07/2007. Seminar 'Ciencia y Tecnologia en Ambientes Acuaticos', U. Austral, PM, Chile.

C. Garcia de Leaniz (UWS, UK)

02/08/2006. Universidad de Los Lagos. Puerto Montt, Chile
01/11/2006. Annual Meeting of the Chilean Genetics Society, Vina del Mar, Chile.
17/01/2007. 1st International Workshop Reducing the Impact of Exotic Aquaculture, PM, Chile
28/03/2007. Aquaculture Research Seminar, Universidad de La Laguna, Tenerife, Spain
27/04/2007. Fish & Loaves Seminar Series, University of Guelph, Inst. Integrative Biology, Canada
30/07/2007. Falkland Islands Chamber of Commerce, Stanley, Falkland Islands
19/10/2007. One-day MSc Symposium, Swansea University, UK.

S. Consuegra (UWS, UK)

20/03/2007. Aquaculture Research Seminar, Swansea University, UK
28/03/2007. Aquaculture Research Seminar, Universidad de La Laguna, Tenerife, Spain

D. Carss (CEH, UK)

18/01/2007. 1st International Workshop Reducing the Impact of Exotic Aquaculture, PM, Chile

G. Giannico (OSU, USA)

17/01/2007. 1st International Workshop Reducing the Impact of Exotic Aquaculture, PM, Chile

Jason Dunham (US Geological Survey, USA)

17/01/2007. 1st International Workshop Reducing the Impact of Exotic Aquaculture, PM, Chile

John Volpe (U. Victoria, Canada)

18/01/2007. 1st International Workshop Reducing the Impact of Exotic Aquaculture, PM, Chile

I.A. Fleming (Memorial University, Canada)

04/12/2006. WWF Aquaculture Dialogue Wk Group on Fish Farm escapes. Trondheim, Norway

19/04/2007. Natural History Society of Newfoundland and Labrador, St. John's, Canada..

02/2007. Aquaculture '07, World Aquaculture Society, San Antonio, USA.

17/01/2007. 1st International Workshop Reducing the Impact of Exotic Aquaculture, PM, Chile

As part of the XIII Week of Science and Technology organized by EXPLORA, a program established by Government to promote science among school children, a day visit was organized on October 2007. The activity was attended by 40 students and a teacher, who learnt of the Darwin Project and toured the laboratory of Genetics & Aquaculture at Osorno (**Annex 3**). Further education and dissemination events will take place during the next period, as per logical framework. For example, a poster on the use of molecular methods for fish stock identification will be presented at the Annual Meeting of the Chilean Genetics Society (7-9 November 2007) in order to disseminate the Darwin project and get feedback from

local researchers. The local coordinator will also give a conference at the Symposium “Marine Biotechnology in the Southern Hemisphere (MBSH2007) on December 2007, which will serve to highlight the use of molecular tools for conservation and to disseminate our work (program at (http://www.mbsh2007.pucv.cl/PROGRAMA_PRELIMINAR_VERSION_INGLES.pdf). The local coordinator is also capitalizing on his position as lecturer at U. de La Frontera (Temuco; PhD program) and U. Los Lagos (Osorno; MSc program) to disseminate the activities of the Darwin Project and to recruit students and volunteers.

Two MSc thesis supervised by the UK-leader were produced in relation to the project (**Annex 5**): Ben J. Perry. “Effects of non-native salmonids on native fish fauna in Chile and the Falkland Islands”, Anne Rees. “Determinants of establishment success among non-native fish” These were presented at a one-day Symposium and their summaries and conclusions posted in the project webpage.

3.2 Progress towards Project Outputs

Overall progress towards achieving project outputs can be considered satisfactory. Valuable links, based on mutual trust, respect and the need for rigorous scientific data, have been forged with the salmon industry and other key stakeholders, including NGO's and Government. It is hoped that continuing dialogue with stakeholders will help to develop (and ensure necessary endorsement of) MAP and CBP towards the end of the project. The main challenges and difficulties lie in the logistics of the project, which in Chile are particularly complicated, and the extreme difficulty of sampling remote aquatic ecosystems, particularly in autumn and winter.

3.3 Standard Output Measures

Training output measures

Training output measures include the attendance by 12 Chilean students (2 undergraduate and 8 postgraduate) to the first project workshop (total attendance c. 45 people each day). Students were issued with official certificates of attendance, jointly signed by the UK leader on behalf of University of Wales Swansea, and the local host coordinator on behalf of Universidad de Los Lagos. Project partners also provided advice and training to RA's during and after the workshop. Dr. Young trained two project volunteers during the first field season, and is currently training two more. Training at the Osorno laboratory included 5 people: three undergraduates and two post-graduate students (including Soledad Cortez, a PhD candidate from Universidad Austral in Valdivia). Project partners in the UK and North America were also involved in the training of 6 further postgraduate students (**Annex 4**), which included the submission of two MSc theses at Swansea University. Other training output measures include an information leaflet highlighting the project objectives and main features, a powerpoint presentation describing the project, a project website in English and Spanish, as well as protocols for field sampling, DNA extraction, mtDNA RFLP analysis, and microsatellite amplification.

Research output measures

Research output measures include a total of 14.8 person/weeks (103 days) spent in Chile working on the project by partners from UK, Canada, and USA during the first 12 months of the project (including Project External Advisor – Prof Ian Fleming). In addition we estimate we have spent an additional 1,500 hrs (excluding time spent by paid staff) in the project, of which 10% (19 days) represents time spent on manuscripts, one submitted (Buschmann et al 20007) and two in preparation. The latter includes a multi-author MS on the role of aquaculture as a source of invasive species, as well as a MS on the hidden costs of exotic aquaculture with particular reference to the Chilean scenario. Results from the two submitted MSc theses include first data on the reproductive biology of the endangered native galaxiid *Aplochiton zebra*, and are also being prepared for publication. The UK and Chilean partners submitted a research grant application to NERC (Assessing the impact of a large-scale salmonid invasion on native fish fauna after the Aysén earthquake – Chile) on September 2007. This was not successful, but a similar application will soon be submitted by Dr. John Volpe to the Canadian Research Council.

Dissemination output measures

Dissemination output measures include the organization of a local community seminar (Vina del Mar, 3 November 2006) and project training workshop (Pto Montt, 16-19 January 2007), 21 oral presentations at national and international seminars/conferences, one feature article in the Darwin Newsletter, one letter to the editor of ‘El Mercurio’ newspaper, four press coverages in the Chilean press, 2 features in the local radio station, and a regularly updated project website (www.biodiversity.cl). We also hosted a one-day visit by school children to the Laboratory of Genetics & Aquaculture (Osorno), and prepared a poster for the forthcoming Annual Meeting of the Chilean Genetics Society. A delegation from Conicyt (National Commission for Science and Technology) and the European Union visited the ULA-Osorno laboratory equipped by the Darwin Initiative, and learnt on the objectives and progress of the project. Finally, Dr. Guillermo Giannico (Oregon State University, USA) submitted an application to the 2008 IUCN World Conservation Congress to host an international workshop on the role of science in assessing the impact of salmon farming on local biodiversity.

Physical output measures

Physical output measures include the allocation of £27,918 in equipment to the ULA Genetics & Aquaculture laboratory, as well as \$1,000 contribution from the International Genetics Federation that was used to allow the UK to give a plenary conference at Annual Meting of the Chilean Genetics Society and publicize the project. Other cash contributions include £ 9,800 secured by ULA to cover accommodation for volunteers (£1,369), additional organization costs for the first workshop (including simultaneous translation; £1,931), as well as £6,486 for the lease of a brand new 4WD vehicle for the duration of the project (**Annex 3**). Contributions in kind include an estimated £4,318 paid directly by partners and stakeholders to attend the first workshop and over £52,000 in time invested by partners on the project, as outlined in Table 1 and **Annex 4**.

Table 1 Project Standard Output Measures (same codes as per last half-yearly report)

Code No.	Description	Year 1
Training outputs		
2A	UG Chilean students attending 1 st workshop and other training	7
4B,D	Training	12 weeks
4C	PG Chilean students attending 1 st workshop and other training PG Non-Chilean students receiving training	10 6
5	RA's training	2
6A,B	Attendance of 1 st workshop and seminar	40
7	Education/training material produced: information leaflet, PowerPoint slideshow, fish sampling protocol, DNA extraction protocol, RFLP mtDNA protocol, microsatellite amplification (multiplex) protocol, website	7
Research outputs		
8	Time spent in Chile by partners (persons/week); UK partners: 8.0 Canada partner*: 3.4; US partners: 3.4	14.8
11A,B	Peer-reviewed MS submitted Peer-reviewed MS in preparation	1 2
Dissemination outputs		
14A	Project training workshop, Local community seminar	2
14B	Presentation conferences/seminars	21
15A,B	Press coverage in Chile (incl. letter to “El Mercurio”)	6
16A	Newsletter	1
17B	Project website, regularly updated and linked to all partners	1
19C	Radio features in Chile	2
20	Equipment	£27,918
23	Cash contribution by International Genetics Federation Contributions in kind by Fundacion Huinay (travel & subsistence field trip) ULA cash contribution to housing of volunteers and 1 st workshop ULA cash contribution to lease of 4WD for duration of project Paid by partners & stakeholders to participate in 1 st workshop Time spent in project (all partners)	US\$1,000 £618 £3,314 £6,486 £4,318 £52,000

Table 2 Publications

Type * (eg journals, manual, CDs)	Detail (title, author, year)	Publishers (name, city)	Available from (eg contact address, website)	Cost £
Conference Proceedings	A.H. Buschmann, F. Cabello, K. Young, J. Carvajal & M.C. Hernández-González. Salmon farming in Chile and organic aquaculture standards: regulations, environmental impacts and bioremediation systems.	National Organic Standards Board (USA)	Proceedings of the Organic Aquaculture Symposium, Washington D.C., Nov. (2007)	
Letter	G. Gajardo & C. García de Leaniz. 2007. Ciencia Básica, Salmonicultura y desarrollo sustentable	El Mercurio	(http://cyt.elmercurio.com/archives/2007/10/ciencia_basica.asp)	
MSc thesis	BJ. Perry. 2007. Effects of non-native salmonids on native fish fauna in Chile and the Falkland Islands	Submitted to Swansea University, Oct 2007	Summary and conclusions in project webpage. www.biodiversity.cl	
MSc thesis	A. Rees. 2007. Determinants of establishment success among non-native fish	Submitted to Swansea University Oct 2007	Summary and conclusions in project webpage. www.biodiversity.cl	
Journal paper in preparation	Biological invasion theory: has aquaculture changed the rules of the game?	In prep		
Journal paper in preparation	Is exotic aquaculture sustainable?	Revista Chilena de Historia Natural (in prep.)		

3.4 Progress towards the project purpose and outcomes

Overall progress towards achieving the project's ultimate goal (To build, in collaboration with government, industry and other stakeholders, the capacity for assessing, monitoring, and reducing the impact of the accidental or deliberate introduction of exotic fish species on Chilean aquatic biodiversity) is still a long way off after the first year into the project but we believe that the necessary steps are being taken. The basic assumptions hold true and the indicators seem adequate

3.5 Progress towards impact on biodiversity, sustainable use or equitable sharing of biodiversity benefits

We believe that the most lasting legacy of our project will be the quality of our scientific results regarding the impact of salmonids upon native aquatic biodiversity, and the development and endorsement of a Management Action Plan and Code of Best Practices in relation to salmonid farming in Chile.

4. Monitoring, evaluation and lessons

We still see the main challenges and difficulties of the project in the logistics, which in Chile are particularly complicated, and the extreme difficulty of sampling remote aquatic ecosystems, particularly in autumn and winter. Dependence during the first few months on rented vehicles and in official (driven) transport proved expensive and unsuitable, so the recent acquisition of a 4WD vehicle by ULA and a lease agreement with the project is greatly facilitating the field work, increasing our capacity for more extensive sampling and surveying. In addition, the skills gained during the first few months, the reception of more sampling gear, and the help of additional volunteers and personnel are making our work more efficient.

We learn this year that support from industry and other stakeholders cannot be taken from granted and that it requires continuous attention, particularly in relation to involvement by stakeholders and funding

from sponsors. The salmon industry is a very dynamic sector with frequent buy-outs and mergers, and a recent change in the top management of Marine Harvest Chile meant that the sponsoring agreement signed by the previous general manager was terminated. We are trying to persuade the sponsor to reconsider its decision through contacts in Europe, but it is clear that we need to be continually alert to monitor (and react to) changes in the sector, and to maintain a close and frequent rapport with key stakeholders.

Research progress was adequate, but slower than we expected. The development and testing of the molecular toolkit is taking longer than we anticipated, and there are still technical problems that we need to address, particularly in relation to the optimisation of multiplexes and a more efficient analysis of samples. Initial delays caused by the difficulty in recruiting suitable laboratory personnel and the shipment of vital equipment hampered our initial progress, but most of these problems have now been sorted out. Loss of tissue samples during air shipment meant that the isotopic analysis could not be carried out, and additional samples need to be collected. International air shipment of fish tissue has proved to be particularly problematic in Chile and will require in the future a more careful and forward planning than we had anticipated. On the other hand, the help of highly motivated and skilled volunteers was particularly fruitful, and valuable results were obtained in 2 MSc theses, which we are encouraging their authors to publish.

Progress in disseminating the project through oral presentations and other activities was very successful, though achieving our (self-imposed) target of two scientific publications in the first year proved more difficult. One ms co-authored by Dr. Kyle Young was sent for publication, but we still have two pending ms to complete (one in collaboration with researcher from other Chilean University). All partners are very conscious of the need to publish, and we see the Second Workshop next December as a good opportunity to review progress and finalize pending ms.

We continue to attract highly motivated volunteers from overseas (Australia, UK, France) to help us with the project, and this is greatly aided by arrangements with ULA to cover accommodation and living expenses. However, recruiting Chilean volunteers is proving more problematic, possibly because volunteering work is less popular among local students. We are taking steps to remedy this situation with a more proactive advertising campaign at Universities and other teaching institutions (**Annex 3**).

Finally, we have continued to react to opportunities using the Darwin Initiative as leverage for securing additional funding and support for the project. Thus, during the first year we submitted applications for (1) a Leverhulme Fellowship for the local host coordinator, (2) a Darwin Fellowship for a Chilean PhD student (C. Correa), (3) a Darwin Scoping Award in collaboration with our contacts in the Falklands, (4) a Coordinating and Support Action to the EU FP7 program in relation to Aquaculture Sustainability, (5) a research grant to NERC (UK) to study the impact of a massive escape event following the recent Aysen earthquake, (6) a proposal to IUCN to host an international workshop during 2008 on the impacts of salmon farming , and (7) a research grant to the Canadian Research Council to examine the impacts of salmon escapes in British Columbia and in Chile.

5. Actions taken in response to previous reviews (if applicable)

We believe we have taken the necessary actions in response to previous comments made by the reviewer, namely: (we expanded on these in section 4 above, as suggested)

1. We have conducted a critical and thorough assessment of progress to date
2. The project is fully staffed since April 2007 when the second RA (Carlos Flores) was appointed.
3. Volunteers and equipment are also in place for the field and laboratory work

6. Other comments on progress not covered elsewhere

No further comments seem necessary

7. Sustainability

Scarcity of suitable baseline data was highlighted by all stakeholders as one of the most important threats to achieving sustainability in the Chilean salmonid industry. Thus, the success of our project will largely depend on the quality of our data on extent and impact of exotic salmonids upon native species, principally fishes. This, we believe, will in turn generate trust and interest and foster capacity for biodiversity.

8. Dissemination

Dissemination activities during the first year of the project were substantial and included the organization of a local community seminar (Vina del Mar, 3 November 2006) and project training workshop (Pto Montt, 16-19 January 2007), 21 oral presentations, one feature article in the Darwin Newsletter (plus contribution to forthcoming Annual Report), six press coverages in the Chilean press, 2 features in the local radio station, and a regularly updated project website (www.biodiversity.cl). We are also finalizing the organization of the Second Workshop (Molecular Ecology of Aquatic Invasions) to be held next 17-19 December 2007 at Vina del Mar.

9. Project Expenditure

Table 3 Project expenditure during the reporting period (Defra Financial Year 01 April to 31 March) – 01 October 2006 – 31 October 2007

Item	Budget (please indicate which document you refer to if other than your project schedule)	Expenditure	Balance
Rent, rates, heating, overheads etc	0	£0	0
Office costs (eg postage, telephone, stationery)	£300	£374	+74
Travel and subsistence	£13,829	£11,556	-2,273
Printing	£600	£734	+134
Conferences, seminars, etc	£2,000	£1,577	-423
Capital items/equipment	£27,918	£21,462	-6,456
Others	£19,934	£14,865	-5,069
Salaries (specify)	Project Mgmt & Assistance £4,000 RA Ecology £8,000 RA Molecular £8,000 Total £20,000	Project Mgmt & Assistance £3,568 RA Ecology (15 Jan 07) £8,477 RA Molecular (01 Apr 07) £6,479 Total £18,556	-1,444
TOTAL	£84,581	£69,124	-15,457

The main differences in the balance lie in capital equipment (there are still a few items pending reception), and in the costs of external sequencing and isotopic analysis which have not yet been carried out due to loss of samples during shipping. There is also a small under spending on T&S as the costs of the forthcoming second workshop have not yet been consolidated, and on salaries due to the late recruitment of the second RA.

10. OPTIONAL: Outstanding achievements of your project during the reporting period (300-400 words maximum). This section may be used for publicity purposes

I agree for ECTF and the Darwin Secretariat to publish the content of this section

Reducing the Impact of Exotic Aquaculture on Chilean Aquatic Biodiversity
Joint statement endorsed by all Stakeholders

Under the auspices of the Darwin Initiative, “Reducing the Impact of Exotic Aquaculture on Chilean Aquatic Biodiversity”, participants in the Working Group recognized the enormous economic and social importance of aquaculture (salmon farming) in Chile, but also on the need to identify those problems that might exist as a consequence of the culture of exotic species (salmonids), and the lack of reference studies (base line data). For these reasons, the Working Group agreed to:

1. Support and facilitate research studies designed to obtain reference data on the distribution, prevalence and impact of exotic species escaping from aquaculture facilities, as well as those studies designed to mitigate possible impacts caused by aquaculture escapees
2. Increase communication and commitment between stakeholders, in order to ensure the final success of the project
3. Work in collaboration with all stakeholders to ensure that Chilean Aquaculture becomes increasingly more sustainable, contributing in this way towards the strengthening of the sector and the protection of the natural environment

Puerto Montt, 16th January 2007

Signed:

Miguel Stutzin (CONAMA, Chile), Adolfo Alvial (INTESAL- SalmonChile, Chile), Roberto Bravo (INTESAL- SalmonChile, Chile), Jorge Ríos (INTESAL- SalmonChile, Chile), Marcelo Urrutia (Salmones MultiExport, Chile), Brendan Gara (Falklands Islands Development Corporation, UK), José D. Núñez (Corporación Río CONTACO, Chile), Daniel Portales (Club de Pesca Ríos del Sur, Chile), Luis Vásquez (Club de Pesca Ríos del Sur, Chile), Vreni Häussermann (Fundación Huinay, Chile), Günter Försterra (Fundación Huinay, Chile), Guillermo Giannico (Oregon State University, USA), Jason B. Dunham (US Geological Survey, USA), Ian a. Fleming (Memorial University, Canada), John Volpe (University of Victoria, Canada), Kyle A. Young (Universidad de los Lagos, Chile), Francisco Orellana (Universidad de los Lagos, Chile), Gonzalo Gajardo (Universidad de los Lagos, Chile), David N. Carss (NERC Centre for Ecology & Hydrology, UK), Carlos García de Leániz (University of Wales Swansea, UK)

Annex 1. Report of progress and achievements against Logical Framework for Financial Year: 2006/07

Project summary	Measurable Indicators	Progress and Achievements April 2006 - March 2007	Actions required/planned for next period
Goal: To draw on expertise relevant to biodiversity from within the United Kingdom to work with local partners in countries rich in biodiversity but constrained in resources to achieve The conservation of biological diversity, The sustainable use of its components, and The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources		<p>See joint statement by stakeholders in www.biodiversity.cl</p> <p>Pto Montt, 16th January 2007</p>	(do not fill not applicable)
Purpose To build, in collaboration with government, industry and other stakeholders, the capacity for assessing, monitoring, and reducing the impact of the accidental or deliberate introduction of exotic fish species on Chilean aquatic biodiversity	<ol style="list-style-type: none"> 1. New knowledge on the distribution and abundance of exotic fish species and their impact upon native aquatic biodiversity 2. Endorsement of a Management Action Plan (MAP) and Code of Best Practice (CBP) in relation to exotic species, introductions and protection of native aquatic biodiversity 3. Increased understanding and public awareness of threats to native bio-diversity resulting from foreign fish introductions 	A joint statement, endorsed by all stakeholders on the need to carry out rigorous research was one of the main outputs from the first project workshop	<ol style="list-style-type: none"> 1. Organization of second training workshop, dissemination 2. Expansion of sampling program 3. Development of databases 4. Testing of molecular methods for GSI 5. Submission of 2 MS: 1 popular science, 1 scientific paper
Output 1. Abundance, distribution, and impact of exotic and naturalized salmonids assessed	1. Findings endorsed by the scientific community and stakeholders	Progress adequate but slower than expected. Abundance and distribution of exotic and naturalized salmonids should also be measured by development of (and reference to) database, in addition to endorsement by scientific community and stakeholders	
Activity 1. Research & monitoring of exotic and naturalized fish species		A sampling field protocol involving a combination of snorkeling and electro-fishing was developed, as well as protocols for collecting samples and carrying out genetic analysis. One salmon farm and 8 rivers in the Aysén region were sampled. Work in the next period will involve expanding the coverage of fish farms and sampling sites, as well as the beginning of genetic analysis	
Output 2. A monitoring and impact assessment programme with trained personnel established	2. GIS database & molecular and isotopic toolkits for identification of exotic and farmed fish species developed, tested, and at least 2 staff trained	Development of GIS database in progress. Development of molecular protocols completed, and network of sampling stations for monitoring identified and agreed. Staff in place. Testing of toolkit for molecular stock identification in progress.	
Activity 2. Capacity building and training in assessing impact of exotic invasions		As per activity 1, involving 2 new hired staff (RA's), 2 technicians and one volunteer. Work in the next period will involve further training of personnel and recruitment of additional volunteers/students.	
Output 3. MAP, CBP, and possible exclusion zones for protecting aquatic biodiversity from exotic invasions	3. MAP and CBP peer reviewed and presented at international conference	Discussed with stakeholders at first workshop, though this output is expected to be completed by end of project. Continuing dialogue with stakeholders will help to develop (and ensure necessary endorsement of) MAP and CBP	
Activity 3. Research & monitoring of exotic and naturalized fish species		As per activity 1.	
Output 4. Educational events and media coverage for local people, fish farmers, and rest of stakeholders	4. Participation of fish farmers and rest of stakeholders in educational events, Darwin project featured in media	Considerable progress was achieved in relation to this output. All major stakeholders actively participated in fist workshop and a joint statement was agreed and publicized (via webpage and media). Darwin project was also publicized at conferences and seminars and featured in several media events.	
Activity 4. Education programme and dissemination of results		Further education events will take place during the next period, as per logical framework. Two manuscripts, as well as press releases, are in preparation, and plans are also being made to attend a suitable conference	

Annex 2. Project's full current logframe

Project summary	Measurable Indicators	Means of verification	Important Assumptions
Purpose To build, in collaboration with government, industry and other stakeholders, the capacity for assessing, monitoring, and reducing the impact of the accidental or deliberate introduction of exotic fish species on Chilean aquatic biodiversity	1. New knowledge on the distribution and abundance of exotic fish species and their impact upon native aquatic biodiversity 2. Endorsement of a Management Action Plan (MAP) and Code of Best Practice (CBP) in relation to exotic species, introductions and protection of native aquatic biodiversity 3. Increased understanding and public awareness of threats to native bio-diversity resulting from foreign fish introductions	1. Project reports, workshop proceedings and publications in peer-reviewed journals 2. Documentation and correspondence for MAP and CBP 3. Records of educational programme and training workshops. Development of professional curricula on sustainable aquaculture. Students trained under programme pass their courses	1. Project findings are understood and accepted by the salmon industry, regulatory agencies and all stakeholders. Policy makers use findings to help reduce the impact of exotic species on local biodiversity 2. Market forces and increased recognition on the impact of exotics facilitate the shift towards more sustainable fish farming 3. Curriculum development is implemented by ULL with the launch of a MSc in Sustainable Aquaculture
Outputs 1. Abundance, distribution, and impact of exotic and naturalized salmonids assessed 2. A monitoring and impact assessment programme with trained personnel established 3. MAP, CBP, and possible exclusion zones for protecting aquatic biodiversity from exotic invasions 4. Educational events and media coverage for local people, fish farmers, and rest of stakeholders	1. Findings endorsed by the scientific community and stakeholders 2. GIS database & molecular and isotopic toolkits for identification of exotic and farmed fish species developed, tested, and at least 2 staff trained 3. MAP and CBP peer reviewed and presented at international conference 4. Participation of fish farmers and rest of stakeholders in educational events, Darwin project featured in media	1. Publication of results in peer reviewed, national and international scientific journals 2. Project reports, scientific papers, abundance and distribution maps, species database, fish escape assessment protocol, project website 3. Workshop proceedings, MAP and CBP published and distributed, copies sent to Darwin Initiative 4. Educational leaflets, press releases, media coverage, reports	1. Sampling strategy and logistic support are appropriate for project objectives and facilitate the collection of data 2. Adequate performance of molecular and isotopic diagnostic toolkits to produce desired results 3. Successful liaison with industry, government agencies and rest of stakeholders for project support 4. Links to educational media and NGO's are established (already in place via ULL)
Activities 1. Capacity building and training in assessing impact of exotic invasions 2. Research & monitoring of exotic and naturalized fish species 3. Education programme and dissemination of results	Activity Milestones Yr1. Initial meetings with stakeholders. Develop GIS database, molecular and isotopic diagnostic toolkits and run training workshops, establish sampling strategy and field protocols. Follow-up training workshops in Yr2 & Yr3. Yr1. Field test diagnostic methods for species identification, stock assignment and trophic niche overlap, begin screening. Yr2 & Yr 3. Continue screening, workshops to discuss results. Yr 3. Writing of scientific publications, MAP and CBP. Yr1. Develop education programme, establish website, and attract media interest. Yr2-Yr3. Develop MSc curriculum, presentation of results at international conferences. All years: annual reports, workshops proceedings, update webpage. At least 2 scientific peer-reviewed papers submitted by end of Yr 3	Assumptions 1. Program receives required support from University (in place). 2. Research methods and tools are adequate. Required baseline information is provided by industry and regulatory bodies 3. Successful liaison with stakeholders and media interest. Support from University	

Annex 3. Photographs

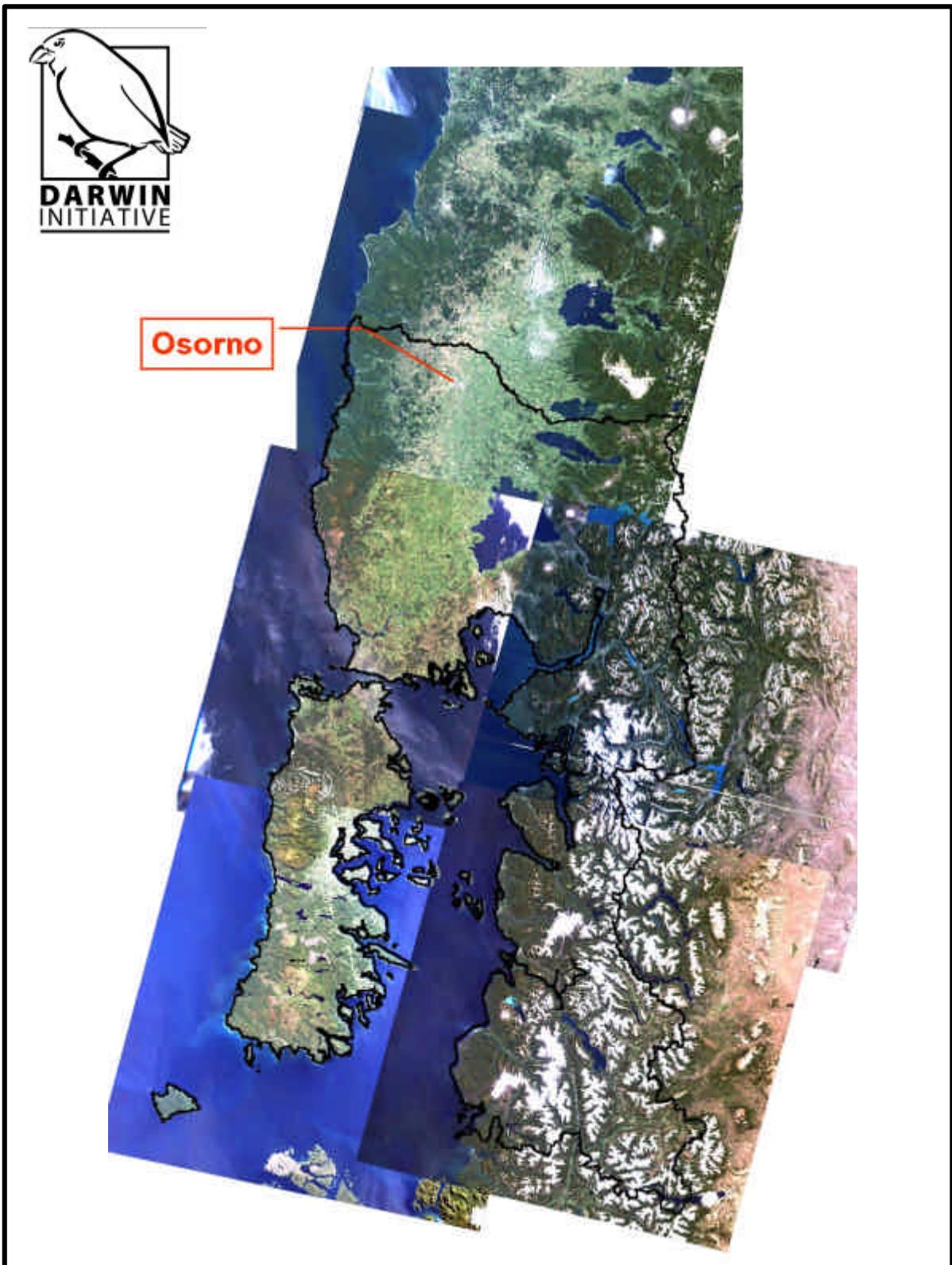


Photo 1. Satellite map of Region X (Los Lagos) where most of the Chilean salmon farming is concentrated

Photo 2. Some of the participants and public who attended the open conferences on Reducing the Impact of Exotic Aquaculture, held at Puerto Montt (17-18 January 2007)



Photo 3. ULA Laboratory of Genetics & Aquaculture (Osorno, Chile) equipped by the Darwin Initiative



Photo 4. New 4WD vehicle purchased by ULA and leased for the duration of the project.



Photo 5. Electro-fishing to determine the abundance of native galaxiid fishes and invasive salmonids in S. Chile.



Photo 6. Flyers and posters in Spanish for recruiting Chilean volunteers.



Oportunidad de trabajo para Voluntarios en el marco de proyecto Internacional: Reducing the Impact of Exotic Aquaculture on Chilean Aquatic Biodiversity (Darwin Initiative, Gran Bretaña)



La Acuicultura Chilena es una industria a gran escala, hasta ahora basada principalmente en el cultivo de especies exóticas, en un ecosistema ambientalmente sensible y de interés mundial por ser relativamente puro aún y por disponer de una biodiversidad de agua dulce altamente endémica. Se sabe que las especies exóticas pueden tener un impacto relevante sobre la biodiversidad nativa, de manera que se requiere información científica de calidad y confiable para ayudar a que los responsables de la toma de decisiones protejan los recursos naturales acuáticos e, igualmente, una industria que es valiosa y que sigue en expansión. El proyecto Darwin Initiative, una iniciativa conjunta entre la Universidad de Gales y la Universidad de Los Lagos, es una oportunidad única para intentar de conciliar lo que existe actualmente para una acuicultura más sustentable y para compatibilizar desarrollo económico con los acuerdos de Biodiversidad que Chile ha suscrito. Para mayor información sobre el proyecto: www.biodiversity.cl

En el marco de este proyecto se ofrecen 2 plazas para Voluntarios:

- 1. Impacto ecológico de la acuicultura exótica.**
Actividad a cargo del Dr. Kyle Young, investigador postdoctoral asociado al proyecto, quien está realizando un catastro de abundancia en diferentes ríos de la región mediante buceo diurno y nocturno. El Dr. Young es un experto ecológico, buceador y junto al Dr. Young participan igualmente como voluntarios los franceses Anne Flore Thallay y Alexandre Terra. La actividad requiere disponer de tiempo para períodos relativamente prolongados en terreno (Puerto Montt y alrededores).
- 2. Ecología molecular de las invasiones acuáticas**
Se contempla el desarrollo y aplicación de marcadores genéticos (microsatélites) para monitorear espacio-temporalmente las especies disponibles en el ecosistema (nativas, naturalizadas y escapadas). La actividad se desarrollará en el Laboratorio de Genética & Acuicultura, Osorno.
Requisitos: se requiere personas proactivas e interesadas en aprender y colaborar en un proyecto de gran trascendencia para el país. Para 1, los voluntarios tienen que disponer de licencia de buzo al día. Se ofrece alojamiento y comida en terreno.
El proyecto Darwin Initiative es una interesante oportunidad para además interactuar con un equipo multinacional de investigadores que se reúnen para la realización de talleres anuales, cuya finalidad es difundir los progresos del proyecto y crear conciencia sobre la necesidad de atacar racionalmente (es decir con una buena base de información) este problema.

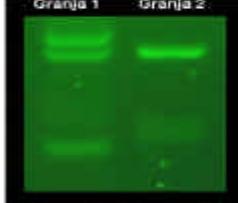


OPORTUNIDADES ESTUDIANTES Y VOLUNTARIOS

¿Te preocupa el medio ambiente chileno?
¿Quieres aprender ecología y genética?
¿Quieres viajar por Patagonia?

?Sí? Necesitamos tu ayuda

El Proyecto Darwin "Reduciendo el impacto de la acuicultura exótica en la biodiversidad acuática chilena" ofrece oportunidades para trabajar en el terreno y en el laboratorio estudiando los impactos de la acuicultura en los peces y ecosistemas de lagos y ríos chilenos.



Analisis genético de microsatélites con DNA de salmón



Los juveniles de salmón utilizan el mismo hábitat que los puyen nativos.



Los salmones exóticos se escapan de las jaulas y entran en los ríos chilenos.

¡Visita nuestra página de red y ponte en contacto!

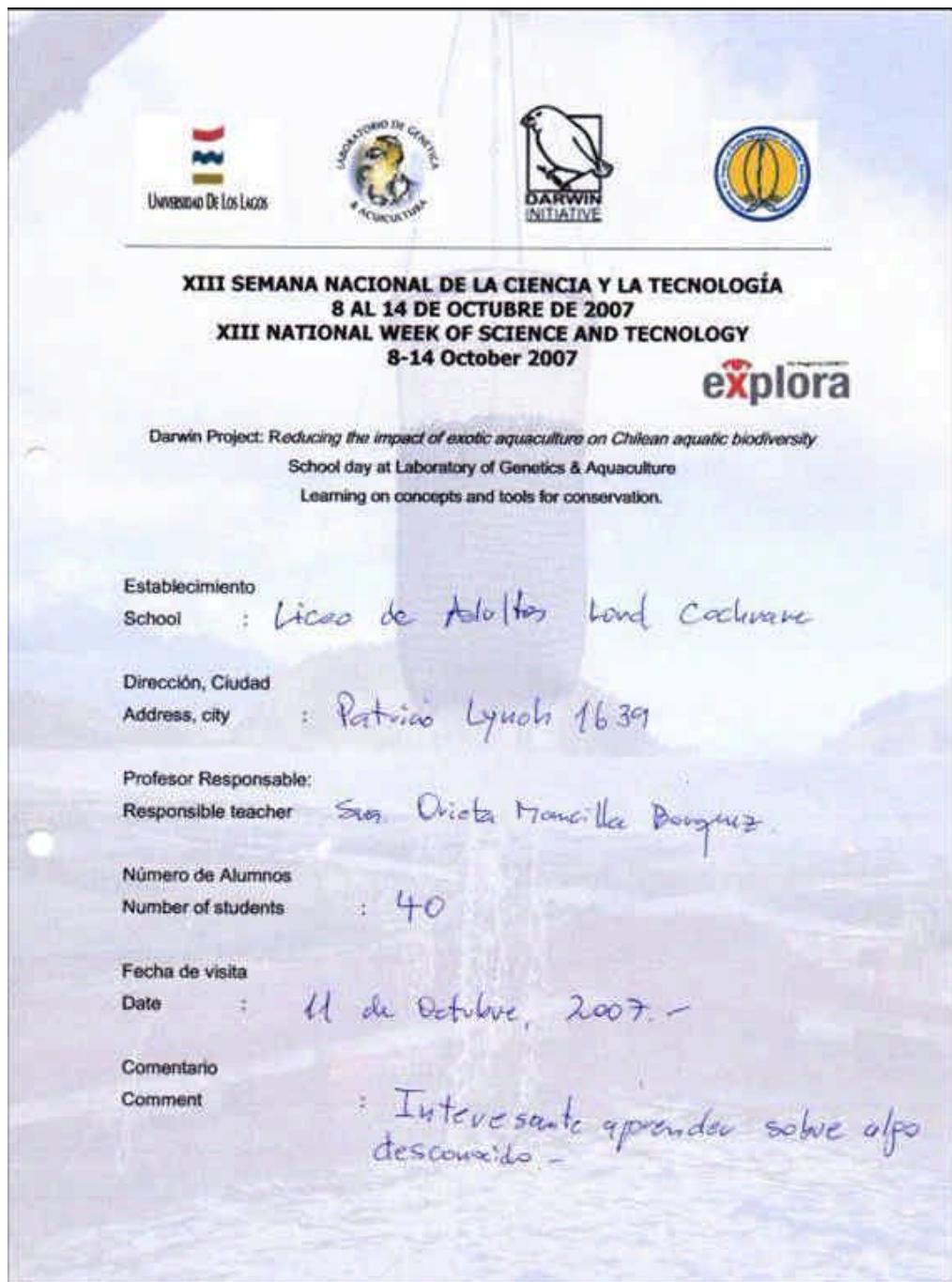
www.biodiversity.cl

ggajardo@ulagos.cl, cflores@ulagos.cl, kyle_a_young@hotmail.com





Photo 7. Dissemination and education activities



Annex 4. Details of individual contributions

Darwin Initiative 15/020 Summary of contributions
Period: 1 October 2006 – 1 October 2007

Partner: Laboratory of Genetics & Aquaculture (LGA, Chile).

Please list the following (use space as required)

1. Presentations at seminars, conferences, lectures, etc. with reference to the Darwin Initiative

1. Date: December 9-13 2007.

Venue: Viña del Mar. Marine Biotechnology in the Southern Hemisphere (MBSH2007).

Author: Gonzalo Gajardo (conference).

Title: Biotechnology and conservation of native biodiversity

(<http://www.mbsh2007.pucv.cl/PROGRAMA PRELIMINAR VERSION INGLES.pdf>).

2. Date: 1. November 7-9 2007..

Venue: Tome, Concepcion. Annual meeting of the Genetics Society of Chile.

Author(s): C. Flores, G. Gajardo, C. García de Leániz & S. Consuegra

Title: Use of microsatellites to evaluate and reduce the impact of exotic aquaculture on Chilean aquatic biodiversity). (abstract attached).

3. Date: July 2007.

Venue: University Los Lagos. Two lectures, Master programme in Natural Resources

Author: Gonzalo Gajardo.

Title: Lectures (2). *The Darwin Initiative: Reducing the impact of exotic aquaculture on native aquatic biodiversity, an international collaboration on conservation*

4. Date: May-June 2007.

Venue: University la Frontera, School of Agriculture. PhD programme Science of Natural Resources.

Author: Gonzalo Gajardo.

Title (several Lectures): Exotic aquaculture and the 2010 target of reducing biodiversity loss.

2. Meetings with stakeholders in relation to the project

During the last 6 months GG has extensively contacted different stakeholders, either seeking cooperation from the industry or in relation to the preparation of the second workshop. Examples are i) GG was invited by Dr. Roberto Neira (organizer) to a meeting aimed at discussing a Salmon Genome Project involving Chile. The meeting was attended by governmental funding agencies (Conicyt, Corfo, Fondef), academics, and guest foreign speakers, most of which were part of the cGRASP project (a multinational salmon initiative based in Norway); ii) On the occasion GG talked to Adolfo Alvial, at that time General Manager of INTESAL (The technological Institute of Salmon), which agreed to interact more closely (Mr. Alvial is presently technical manager at Marine Harvest). iii) In relation to the second project workshop, which will be held in Viña del Mar in December 17-19, the following persons have been contacted/invited: Ricardo Galleguillos (U. Concepcion); Jorge Toro (U. Austral de Chile); Miguel Stutzin (Conama); Ricardo Norambuena (Undersecretary of Fisheries); Kathleen Witlock (U. Valparaiso, Genomic studies Unit), Víctor Martínez (U. of Chile), Elie Poulin (U of Chile), Miguel Pascual (Argentina), Jose Luis Ciancio (Argentina), Marcela Astorga (U. Austral de Chile), Evelyn Habit (U. Concepcion), Juan Venegas (U. Chile). Last, but not least, Dr. Cornelia Nauen, European Union officer in charge of promoting Europe-South America cooperation, considered in her visit to southern Chile the laboratory of Genetics & Aquaculture (Thursday 25 October). She will be accompanied by Mrs. Ximena Gómez de la Torre, representative of Conicyt (National Comission for science and technology).

3. Written contributions (formal or informal) arising from your involvement in the project

Date: July 2007

Title: Salmon farming in troubled waters: coming to terms with exotic aquaculture in Chile

Author(s): C. Garcia de Leaniz & G. Gajardo.

Reference: Darwin Newsletter Issue 9, July 2007

http://www.darwin.gov.uk/downloads/newsletters/DARWIN_NEWS_9.pdf

Date: 22 Oct 2007

Title: Ciencia Básica, Salmonicultura y Desarrollo Sustentable

Author(s): G. Gajardo & C. Garcia de Leaniz

Reference: Letter to El Mercurio http://cyt.elmercurio.com/archives/2007/10/ciencia_basica.asp

MS in preparation

4. Training given in relation to the project

1. Date: July 2007.

Trainee: Amilcar Arriagada, undergraduate student from Catholic University, Valparaiso.

Subject: Information and practical training on molecular protocols considered in the project.

Venue: Laboratory of Genetics & Aquaculture (LGA).

2. Date: July 30 to August 3 2007

Trainee: Michael Veimann, last-year student from the German School, Osorno.

Subject: Vocational week, prior to take a decision on following a science career. DNA extraction and quantification, use of laboratory equipment.

Venue: LGA.

3. Date(s): August 7-8 2007.

Trainee(s): Carlos Flores

Subject: Use of ABI 310 sequencer and data interpretation.

Venue: P. Catholic University, Santiago. Chile.

3. Date: August- September 2007.

Trainee: Héctor Venegas. Undergraduate student of aquaculture, University Los Lagos, Osorno, who would like to do his thesis project in the laboratory.

Subject: Genetic markers in trout

4. Date: July 2007

Trainee: Soledad Cortez

Subject: PhD student University Austral (programme on Systematic and Ecology). She is willing to do a thesis on Galaxid fishes in the laboratory, after her qualification exam.

5. Any other dissemination activity that may help towards achieving the objectives of the project

Date(s): 12 October

Subject: Explora-Conicyt, programme for the dissemination of science into schools. Open labs day.

Venue: LGA (see letter attached).

6. Contributions in kind to the project

Date: for the period considered in this report

Type: Salary: Management, research and field logistic

Estimated value: £10,000 pounds

7. Estimated time spent on the project

Time (hrs): 800

Estimated value: £ 15000

Darwin Initiative 15/020 Summary of contributions
Period : 1 October 2006 – 1 October 2007

Partner: Kyle A. Young (U. Los Lagos, Chile)
Please list the following (use space as required)

1. Presentations at seminars, conferences, lectures, etc. with reference to the Darwin Initiative

Date: 17/1/2007

Venue: Peninsula Hotel, Puerto Montt, Chile. First International Workshop of the Darwin Initiative.

Author(s): Kyle A. Young

Title: "The effects of salmon and trout on stream ecosystems: patterns, processes and challenges"

Date: 6/7/2007

Venue: Universidad Austral, Puerto Montt, Chile. Seminario en series 'ciencia y tecnologia en ambientes acuaticos', organizad by ULA, IMAR, UAC, and CIEN-Austral

Author(s): Kyle A. Young

Title: "The potential effects of salmonid aquaculture on freshwater biodiversity in Chile"

2. Meetings with stakeholders in relation to the project

Stakeholder: Alejandro Kauffman O'Reilly-Presidente "Club de Pesca y Caza Lican-Ray", Villarrica Chile

Date: 10-15/7/2007

Location: email

Subject: Alejandro contacted me to discuss the potential impacts of the Pullinque Dam on the wild fish populations of the Siete Lagos Basin. He was directed toward the project web page and asked to mention the Darwin Initiative in any public dissemination of the ideas I shared.

Stakeholder: Eduardo Cerda- Quality Control Manager, Atlantis Chile.

Date: 13/7/2007

Location: email

Subject: Eduardo contacted me regarding paid job opportunities with their company in Puerto Aysen. His email was forwarded by me to Darwin Initiative members who teach at regional universities.

3. Written contributions (formal or informal) arising from your involvement in the project

Date: July-Sept 2007

Title: "Salmon farming in Chile and organic aquaculture standards: regulations, environmental impacts and bioremediation systems"

Author(s): Alejandro H. Buschmann*, Felipe Cabello, Kyle Young, Juan Carvajal and María C. Hernández-González

Reference: Forthcoming Proceedings-National Organic Standards Board (USA), Proceedings-Organic Aquaculture Symposium, Washington D.C., Nov. 2007.

4. Training given in relation to the project

Date(s): March-Sept. 2007

Trainee(s): Jane McDonald (Australia)

Subject: Fish Ecology

Venue: Regions 10 & 11, southern Chile. Jane was trained under the volunteer program of the Darwin Initiative- fish identification and dissection, day and night time snorkelling, electrofishing, stream habitat assessment, macroinvertebrate sampling, experimental design.

Date(s): June-July. 2007

Trainee(s): Ben Perry (UK)

Subject: Fish Ecology

Venue: Ben completed his MSc. thesis under the supervision of Darwin Initiative partners. During his time in southern Chile he studied interactions between native fishes and exotic salmonids in three rivers of the Lago Llanquihue basin-fish identification and dissection, night snorkelling, stream habitat assessment, macroinvertebrate sampling, experimental design.

Date(s): Sept. 2007-ongoing

Trainee(s): Anne Flore Thailly, Alexandre Terreau (France)

Subject: Fish Ecology

Venue: Regions 10 & 11, southern Chile. Anne Flore and Alexandre are being trained under the volunteer program of the Darwin Initiative-fish identification and dissection, day and night time snorkelling, electrofishing, stream habitat assessment, macroinvertebrate sampling, experimental design.

5. Any other dissemination activity that may help towards achieving the objectives of the project

Contact: Andrew Gerhart, PhD candidate, Interdisciplinary Graduate Program in Environment and Resources, Stanford University.

Date(s): 29/8/2007

Subject: Andrew was directed to me by project member John Volpe and is interested in studying the social-economic-ecological interface of salmonid aquaculture in Chile. He and I had a 4 hour meeting during which I informed him of the project and offered our cooperation and assistance during his thesis work.

Venue: Universidad de Los Lagos, Puerto Montt, Chile

Contact: Dr.Scott Tiegs, postdoctoral researcher, University of Notre Dame, USA

Date(s): 27/9/2007

Subject: Dr. Tiegs and I initiated a collaborative proposal (NSF, USA) to study the potential effects on Chilean stream ecosystems of marine nutrient subsidies associated with rapidly expanding chinook salmon populations. Dr. Tiegs' research group is presently studying how anthropogenic disturbance (primarily logging) regulates these effects within (Alaska, USA) and outside (Great Lakes, USA and Canada) the native range of anadromous salmonids. If successful, this project will bring together scientists from North America, Europe and Chile to investigate how an exotic keystone species affects different components of invaded ecosystems.

Venue: telephone

6. Contributions in kind to the project

Date: Jan. 2007-ongoing

Type: waders and boots, dry suit and snorkelling gear, GPS unit, digital camera with underwater housing.

Estimated value: 3,000 British pounds

7. Estimated time spent on the project

Time (hrs): 40 hours/week;

Estimated value: salaried employee.

Darwin Initiative 15/020 Summary of contributions
Period : 1 October 2006 – 1 October 2007

Partner: Carlos Garcia de Leaniz (UWS, UK)
Please list the following (use space as required)

1. Presentations at seminars, conferences, lectures, etc. with reference to the Darwin Initiative

Date: August 2006

Venue: Universidad de Los Lagos. Meeting with stakeholders, Puerto Montt, Chile

Author(s): C. Garcia de Leaniz

Title: Introducing the Darwin Initiative “Reducing the Impact of Exotic Aquaculture on Chilean Aquatic Biodiversity”

Date: 01 November 2006

Venue: Annual Meeting of the Chilean Genetics Society (keynote talk), Vina del Mar, Chile.

Author(s): C. Garcia de Leaniz, Fleming, I. A., Einum, S., Verspoor, E., Jordan, W. C., Consuegra, S., Aubin-Horth, N., Lajus, D., Letcher, B. H., Youngson, A. F., Webb, J. H., Vøllestad, L. A., Villanueva, B., Ferguson, A., & Quinn, T. P.

Title: Adaptaciones locales y variacion genética adaptativa en salmonidos: implicaciones para la conservación

Date: 17 January 2007

Venue: First International Workshop on Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity. Puerto Montt, Chile

Author(s): C. Garcia de Leaniz

Title: Introducing the Darwin Initiative project “Reducing the Impact of Exotic Aquaculture on Chilean Aquatic Biodiversity”

Date: 17 January 2007

Venue: First International Workshop on Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity. Puerto Montt, Chile

Author(s): C. Garcia de Leaniz

Title: Are salmonids really locally adapted? - implications for managing farm escapes

Date: 28 March 2007

Venue: Aquaculture Research Seminar, Universidad de La Laguna, Tenerife, Spain

Author(s): C. Garcia de Leaniz

Title: Aquaculture as a source of invasive species

Date: 27 April 2007

Venue: Fish & Loaves Seminar Series, University of Guelph, Institute of Integrative Biology, Guelph, Canada

Author(s): C. Garcia de Leaniz

Title: Aquaculture as a source of invasive species

Date: 30 July 2007

Venue: Meeting with stakeholders. Falkland Islands Chamber of Commerce, Stanley, Falkland Islands

Author(s): C. Garcia de Leaniz

Title: Conservation strategies for Falkland Islands freshwater fish biodiversity

Date: 19 October 2007

Venue: Swansea University, Biological Sciences, UK. One-day MSc Symposium.

Author(s): BJ. Perry (supervisor: C. Garcia de Leaniz)

Title: Effects of non-native salmonids on native fish fauna in Chile and the Falkland Islands

Date: 19 October 2007

Venue: Swansea University, Biological Sciences, UK. One-day MSc Symposium.

Author(s): A. Rees (supervisor: C. Garcia de Leaniz)

Title: Determinant of establishment success among non-native fish

2. Meetings with stakeholders in relation to the project

Date: August 2006

Location: Osorno & Puerto Montt, Chile

Subject: Initial meeting with stakeholders, including industry

Date: 2-3 November 2006

Location: Vina del Mar, Chile O

Subject: Annual Meeting Genetics Society of Chile, meeting with Academic and Government officials

Date: 16-19 January 2007

Location: Puerto Montt, Chile

Subject: First International Workshop on Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity. Meeting with all major stakeholders

Date: 27 July & 5 August 2007

Location: Puerto Montt & Santiago, Chile

Subject: Project coordination meetings

3. Written contributions (formal or informal) arising from your involvement in the project

Date: July 2007

Title: Salmon farming in troubled waters: coming to terms with exotic aquaculture in Chile

Author(s): C. Garcia de Leaniz & G. Gajardo.

Reference: Darwin Newsletter Issue 9, July 2007

http://www.darwin.gov.uk/downloads/newsletters/DARWIN_NEWS_9.pdf

Date: 22 Oct 2007

Title: Ciencia Básica, Salmonicultura y Desarrollo Sustentable

Author(s): G. Gajardo & C. Garcia de Leaniz

Reference: Letter to El Mercurio http://cyt.elmercurio.com/archives/2007/10/ciencia_basica.asp

4. Training given in relation to the project

Date(s): June-October 2007

Trainee(s): Ben J. Perry (MSc student)

Subject: Effects of non-native salmonids on native fish fauna in Chile and the Falkland Islands

Venue: Swansea University & Falkland Islands

Date(s): June-October 2007

Trainee(s): Anne Rees (MSc student)

Subject: Determinants of establishment success among non-native fish

Venue: Swansea University

5. Any other dissemination activity that may help towards achieving the objectives of the project

Project Coordination & activities listed in Annual Report . 2007 Darwin Scoping Award

6. Contributions in kind to the project

Consumables and various items for field sampling including 2,000 vials, bags, scale packages, alcyan blue, panjet, fish measuring board, egg counting board, stop watch and sampling protocols.

7. Estimated time spent on the project

Time (hrs): +550 hrs . Estimated value: \$17,000

Darwin Initiative 15/020 Summary of contributions
Period : 1 October 2006 – 1 October 2007

Partner: Sofia Consuegra (UWS, UK)
Please list the following (use space as required)

1. Presentations at seminars, conferences, lectures, etc. with reference to the Darwin Initiative

Date: March 20th 2007

Venue: Swansea University (Swansea, UK)

Author(s): Consuegra, S.

Title: Molecular methods in aquaculture: Estimating effective population size and parentage

Date: March 28th 2007

Venue: University of La Laguna (Tenerife, Spain)

Author(s): Consuegra, S.

Title: Mate choice in aquaculture, is it relevant?

2. Meetings with stakeholders in relation to the project

Date: August 2006

Location: Osorno & Puerto Montt, Chile

Subject: Initial meeting with stakeholders, including industry

Date: 27 July 2007

Location: Puerto Montt, Chile

Subject: Project coordination meeting. Molecular methods to identify aquaculture salmonid escapes.

Date: 5 August 2007

Location: Santiago, Chile

Subject: Project coordination meetings

3. Written contributions (formal or informal) arising from your involvement in the project

Date: November 8th 2006

Title: Protocolos para la extraccion y amplificacion de microsatelites y ADN mitocondrial para GSI.

Author(s): Consuegra, S.

Reference: Laboratory protocol

Date: July 12th 2007

Title: Most common criteria used for classifying non-native fish as naturalised (Summary table).

Author(s): Consuegra, S.

Reference: In prep

4. Training given in relation to the project

Date(s): ongoing

Trainee(s): Carlos Flores (Chile)

Subject: Molecular genetic methods. Microsatellite and mitochondrial DNA analyses techniques for Genetic Stock Identification (GSI) of aquaculture-escaped salmonids.

Venue: Chile and UK (telephone and e-mail)

5. Any other dissemination activity that may help towards achieving the objectives of the project
2007 Darwin Scoping Award

6. Contributions in kind to the project

7. Estimated time spent on the project

Time (hrs): 200. Estimated value: £2600

Darwin Initiative 15/020 Summary of contributions
Period : 1 October 2006 – 1 October 2007

Partner: Dave Carss (NERC CEH, UK)
Please list the following (use space as required)

1. Presentations at seminars, conferences, lectures, etc. with reference to the Darwin Initiative

Date: 15-21 January 2007

Venue: First International Workshop Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity, Puerto Montt (Chile)

Author(s): Carss, D N

Title: Cage aquaculture with native and non-native species in Scotland: impacts and mitigation

2. Meetings with stakeholders in relation to the project

Date: As above

Location:

Subject:

3. Written contributions (formal or informal) arising from your involvement in the project

Date: As above – abstract for presentation

Title:

Author(s)

Reference:

4. Training given in relation to the project

Date(s): As above

Trainee(s):

Subject:

Venue:

5. Any other dissemination activity that may help towards achieving the objectives of the project

6. Contributions in kind to the project

7. Estimated time spent on the project

Time (hrs): 124

Estimated value: £10,887.20 at FEC

Darwin Initiative 15/020 Summary of contributions
Period : 1 October 2006 – 1 October 2007

Partner: John Volpe (University of Victoria, Canada)
Please list the following (use space as required)

1. Presentations at seminars, conferences, lectures, etc. with reference to the Darwin Initiative

Date: January 18 2007

Venue: Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity; Puerto Montt

Author(s): J.P. Volpe

Title: *Behavioural ecology of farm-escaped Atlantic salmon in coastal British Columbia , Canada*

2. Meetings with stakeholders in relation to the project

Date: January 15 – 21 2007

Location: Puerto Montt and environs

Subject: Sustainable aquaculture and escapees

3. Written contributions (formal or informal) arising from your involvement in the project

Date:

Title:

Author(s)

Reference:

4. Training given in relation to the project

Date(s): ongoing

Trainee(s): Kris Kloehn (Canada)

Subject: GIS mediated risk assessment tools for mitigation of aquaculture-escaped salmon

Venue: Canada and hopefully Chile

Date(s): January 20-21 2007

Trainee(s): Cristián Correa (Chile)

Subject: Snorkel-survey techniques for assessing exotic salmon abundance

Venue: Huinay, Chile

5. Any other dissemination activity that may help towards achieving the objectives of the project

Date(s):

Subject:

Venue:

6. Contributions in kind to the project

Date: Various

Type: Oversight and funding proposals

Estimated value: All pending ~ Cad\$50,000

7. Estimated time spent on the project

Time (hrs): 250

Estimated value: \$25,000

Darwin Initiative 15/020 Summary of contributions
Period : 1 October 2006 – 1 October 2007

Partner: Jason Dunham (US Geological Survey, USA)
Please list the following (use space as required)

1. Presentations at seminars, conferences, lectures, etc. with reference to the Darwin Initiative

Date: 17 January 2007

Venue: First International Workshop on Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity. Puerto Montt, Chile

Author(s): Jason Dunham

Title: *Invasions of non-native trout – managing for control or coexistence?*

2. Meetings with stakeholders in relation to the project

Date: 16-19 January 2007

Location: Puerto Montt, Chile

Subject: First International Workshop on Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity. Meeting with all major stakeholders

3. Written contributions (formal or informal) arising from your involvement in the project

Date:

Title:

Author(s)

Reference:

4. Training given in relation to the project

Date(s):

Trainee(s):

Subject:

Venue:

5. Any other dissemination activity that may help towards achieving the objectives of the project

Date(s):

Subject:

Venue:

6. Contributions in kind to the project

Date: Jan 2007

Type: Travel and hotel expenses 1st Darwin workshop, Pto Montt

Estimated value: \$3,000

7. Estimated time spent on the project

Time (hrs): 5% time in 2007 spent on workshop and MS

Estimated value: \$5,000

**Darwin Initiative 15/020 Summary of contributions
Period : 1 October 2006 – 1 October 2007**

Partner: Guillermo R. Giannico (OSU, USA)
Please list the following (use space as required)

1. Presentations at seminars, conferences, lectures, etc. with reference to the Darwin Initiative

Date: January 15-21, 2007

Venue: Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity Workshop, Puerto Montt, Chile.

Author(s): Guillermo Giannico

Title: Recurring impacts from non-persistent fish: perspectives on interactions between wild and artificially-produced salmonids

2. Meetings with stakeholders in relation to the project

Date: January 15-21, 2007

Location: Puerto Montt and vicinity, Chile.

Subject: interacted with representatives of salmon farming industry, NGOs and government during and after workshop. Visited several salmon farms and a research station.

3. Written contributions (formal or informal) arising from your involvement in the project

Date:

Title:

Author(s)

Reference:

4. Training given in relation to the project

Date(s):

Trainee(s):

Subject:

Venue:

5. Any other dissemination activity that may help towards achieving the objectives of the project

Date(s):

Subject:

Venue:

6. Contributions in kind to the project

Date: During various times between October 2006 and October 2007

Type: Contributed to workshop organization and coordination, gave a talk, facilitated discussion sessions, contributed material to publication currently under development, prepared proposal for workshop at 2008 IUCN meeting in Barcelona, Spain.

Estimated value: \$10,000 (salary and benefits plus the costs associated with lodging and per diems while in Chile)

7. Estimated time spent on the project

Time (hrs): approximately 120 hrs.

Estimated value: \$7,500 (salary and benefits)

Darwin Initiative 15/020 Summary of contributions
Period : 1 October 2006 – 1 October 2007

External Project Advisor: Ian Fleming (Memorial University of Newfoundland, Canada)
Please list the following (use space as required)

1. Presentations at seminars, conferences, lectures, etc. with reference to the Darwin Initiative

Date: 19 April 2007

Venue: Natural History Society of Newfoundland and Labrador, St. John's, Canada..

Author(s): IA Fleming

Title: Salmonids in aquaculture.

Date: February 2007

Venue: Aquaculture 2007, Science for Sustainable Aquaculture, World Aquaculture Society Meeting, San Antonio, Texas, USA.

Author(s): Thorstad, E.B., Fleming, I.A., McGinnity, P., Ryan, J., Soto, D., Wennevik, V. and Whoriskey

Title: The state of information on salmon aquaculture escapes and the environment - overview and research gaps.

Date: 17 January 2007

Venue: First International Workshop on Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity. Puerto Montt, Chile

Author(s): IA Fleming

Title: Cultural Invasions: understanding the potential for, and implications of fish farm escapes.

Date: 4 December 2006

Venue: World Wildlife Fund Aquaculture Dialogue working group meeting on fish farm escapes.

Trondheim, Norway

Author(s): IA Fleming

Title: Ecological interactions between wild and farm Atlantic salmon.

2. Meetings with stakeholders in relation to the project

Date: January 2007

Location: Puerto Montt, Chile

Subject: First International Workshop on Reducing the Impact of Exotic Aquaculture on Native Aquatic Biodiversity.

3. Written contributions (formal or informal) arising from your involvement in the project

Date: In press

Title: Incidence and impacts of escaped farmed Atlantic salmon, *Salmo salar*, in nature. Report of the Technical Working Group on Escapes of the Salmon Aquaculture Dialogue, World Wildlife Fund.

Author(s) Thorstad, E.B., Fleming, I.A., McGinnity, P., Ryan, J., Soto, D., Wennevik, V. & Whoriskey, F.

Reference: Thorstad, E.B., Fleming, I.A., McGinnity, P., Ryan, J., Soto, D., Wennevik, V. & Whoriskey, F. Incidence and impacts of escaped farmed Atlantic salmon, *Salmo salar*, in nature. Report of the Technical Working Group on Escapes of the Salmon Aquaculture Dialogue, World Wildlife Fund, *in press*.

Also, there is the Aquaculture MS – though a complete draft of the MS awaits

4. Training given in relation to the project

Date(s): started September 2007

Trainee(s): Peter Westley (PhD candidate)

Subject: Evolutionary ecological consequences of invasive brown trout

Venue: Memorial University of Newfoundland

5. Any other dissemination activity that may help towards achieving the objectives of the project

6. Contributions in kind to the project

7. Estimated time spent on the project

Time (hrs): meeting in Chile (13-24 Jan 2007) & preparation ~ 100 hr; work on MS & comments regarding ICUN meeting, & other associated miscellaneous activity ~ 25 hrs

Estimated value: \$7,500

Annex 5. Summaries & Conclusions of MSc theses

Effects of non-native salmonids on native fish fauna in Chile and the Falkland Islands



Photo: Kyle Young



Photo: Dan Fowler

Benjamin James Perry

**Submitted in partial fulfilment for the degree of
MSc in Aquaculture and the Environment**

October 2007

Summary

The deliberate introduction of non-native salmonids into the S. Hemisphere for sport fishing, and more recently accidentally through aquaculture, is thought to have caused severe impacts upon native fish fauna. However, much of the evidence is circumstantial and attributed singularly to predation. This study examines the spatial distribution, relative abundance and resource overlap of non-native salmonids and native galaxiid fishes in streams in Chile and the Falkland Islands. In three Chilean streams around Lake Llanquihue, brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) found in sympatry with native galaxiids constituted 76% of the total fish biomass. The relative abundance of salmonids increased significantly with distance from the river mouth, and their abundance was negatively correlated to that of native fish (*Galaxias plateii* -Puye grande, *Galaxias maculatus* - Puye chico, and *Trichomycterus aerolatus*). Analysis of resource overlap suggested that rainbow trout and puye grande competed for the same habitats and prey items, though the niche of rainbow trout was wider, and thus more generalist than that of puye grande. In East Falkland, brown trout and the two native galaxiids, puye chico (called there Falklands minnow) and zebra trout (*Aplochiton zebra*) were only found in complete allopatry. Falkland streams contained either brown trout or galaxiids, but not both (complementary distributions). Zebra trout and brown trout fed on similar preys, but the niche breadth of zebra trout was much narrower, denoting a more specialized diet. As in Chile, no evidence was found of predation by salmonids on native galaxiids, though the salmonids examined were mostly small (< 250 mm). Thus, while salmonid predation may be important amongst the larger size classes, resource competition, and in particular competition for food, appears to be main cause for the apparent displacement and decline of native galaxiids.

Key words: Salmonid aquaculture; Falkland Islands; Chile; Galaxiidae; Salmonids; non-native introductions; competition.



Conclusions

From this study the following preliminary conclusions can be drawn with regards to the deliberate (sport fishing) and accidental (aquaculture) introductions of non-native salmonids into Chile and the Falkland Islands:

1. Non-native salmonids were the dominant species in three sampled streams in Chile (76% of biomass) and in one of the three streams sampled in the Falklands (100% of biomass).
2. The median size of salmonids significantly exceeded that of native galaxiids in all streams where the two families coexisted. However, I found no evidence of salmonid predation upon native galaxiids in Chile or in the Falklands.
3. In Chile, non-native salmonids were significantly more abundant with increasing distance from the sea, in contrast to galaxiids which seemed to be restricted to the lower stream sections.
4. In general, non-native salmonids occupied a wider, and therefore more generalist, niche than native galaxiids, which may be a characteristic of successful invaders.
5. Substantial niche overlap in habitat and diet was estimated between non-native salmonids and native galaxiids (but not between galaxiids), suggesting that there may be scope for direct resource competition.
6. Taken together, the results of this study suggest that the plasticity of salmonids may have conferred them a competitive advantage over native galaxiids, and this could perhaps explain their rapid spread and colonization of new habitats in the S. Hemisphere.
7. As salmonid farming continues to expand into the S. Hemisphere, it will inevitably bring about further non native introductions. However, as some salmonids are already naturalized in many freshwater systems, the potential impact of aquaculture escapees cannot be established without first studying the interactions between naturalized fish and native fish species.

Determinants of establishment success among non-native fish



Chinook salmon; Photo: Tom Quinn

Ann Rees

**Submitted in partial fulfilment for the degree of
MSc in Environmental Biology**

October 2007

Summary

There is great concern about the influx of invasive fish species globally, which are being introduced to new aquatic environments by anthropogenic activities, and pose a serious threat to aquatic biodiversity. Management strategies are therefore needed to control and minimize the spread of alien fish species, but little data is available about what determines establishment success. I compiled information on life history traits, vectors of introduction, and invasiveness on 135 fish species from two databases (FishBase and DIAS), and developed a predictive framework for categorising them according to their likelihood of success. Establishment success differed significantly between fish families, suggesting that life history traits might be important. Establishment success was positively correlated with fish growth across families, and varied significantly depending on trophic status and migration strategy.

Omnivorous, as well as catadromous and amphidromous species had higher success than other fishes species, suggesting that plasticity might an important determinant of invasion success. Body size, life span and fecundity were negatively correlated with establishment success, while parental care was positively related. Extrinsic factors such as climate, type of aquatic environment, and variation in habitat niches were also found to determine likelihood of establishment. Invasions tended to be more successful in freshwater habitats and in subtropical climates than in other places, but the pathways of introduction were also influential. Thus species introduced simultaneously through multiple routes (including aquaculture) achieved the highest establishment success, followed by those that diffused from neighbouring countries and those that were introduced for sport or pest control purposes. Aquaculture was one of the most pervasive routes of introductions but establishment success varied widely between invasive fish species. There was a positive correlation between establishment success and frequency of adverse ecological effects, suggesting

that managers could use proxies of establishment success to predict ecological impacts.

However, the results also show that fish invasiveness arises from a complex interplay of biotic and abiotic factors, and that both aspects must be considered to develop efficient control strategies for predicting and managing ecological damage.



Conclusions

1. Establishment success differed significantly among fish families, suggesting that variation in life history traits can influence fish invasions.
2. Large body size, long life span, and high fecundity were negatively correlated with establishment success, whereas rapid growth, parental care, amphidromy-cataadromy and omnivory were positively related. This suggests that small, short lived fish, exhibiting parental care and fast turnover, as well as migratory fish with broad diets, are more likely to become established and suggests that plasticity in phenotypic response is an important trait of successful fish invaders.
3. Climate type and habitat niche also influenced establishment success of exotic fish. Establishment was significantly higher in freshwater than in marine environments. Invasions taken place in subtropical and tropical climates, as well as in benthopelagic niches, were also more likely to become successful.
4. Success of fish invasions also varied significantly among introduction pathways. Aquaculture was the predominant source of fish invasions, but was not the most successful route. Highest establishment success (89%) was found when a species was introduced simultaneously through multiple routes, including aquaculture. Diffusion from neighbouring countries, pest control, and sport fishing were amongst the most successful routes of introductions of exotic fish.
5. A significant positive relationship was found between establishment success and frequency of adverse ecological effects, indicating that invasive fish tend to cause ecological degradation of aquatic environments.

Annex 6. Checklist for submission

	Check
Is the report less than 5MB? If so, please email to Darwin-Projects@ectf-ed.org.uk putting the project number in the Subject line.	Yes
Is your report more than 5MB? If so, please advise Darwin-Projects@ectf-ed.org.uk that the report will be send by post on CD, putting the project number in the Subject line.	No
Do you have hard copies of material you want to submit with the report? If so, please make this clear in the covering email and ensure all material is marked with the project number.	No
Have you completed the Project Expenditure table?	Yes
Do not include claim forms or communications for Defra with this report.	OK