Findings and Recommendations Report

WWF International Assessment Mission for the Carlos Anwandter Nature Sanctuary and CELCO pulp mill controversy in Valdivia, Chile.

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FINDINGS AND RECOMMENDATIONS REPORT

I. Background

1. A WWF International Mission addressed the situation in one of Chile's most important wetland systems, the first site included by the Chilean Government in the List of Wetlands of International Importance[1] (and the first such site in all of South America): the Carlos Anwandter Nature Sanctuary, in the southernmost province of Valdivia.

2. In 2004-2005, the Sanctuary has suffered a process of rapid environmental degradation, including the precipitous, massive die-off and migration of one of the largest breeding colonies of black-necked swans (*Cygnus melancoryphus*) in South America, together with thousands of other water birds from several species. According to research commissioned by the National Environmental Comission (CONAMA), and conducted by the Austral University of Chile (UACh), this collapse was principally caused by effluents from a newly-installed pulp mill owned by CELCO, although these conclusions are contested by the company. While a full scientific explanation of changes in the ecology of the wetlands may take several years to develop, it appears that the water bird populations were affected in the first instance by the die-off of the aquatic vegetation, their principal food source, caused by contaminants coming from the pulp mill.[2]

3. The Sanctuary covers 4,877 hectares of wetlands along the Cruces River, one of the affluents flowing into the Valdivia River estuary. It forms part of a 250 km fluvial network surrounding the city of Valdivia in Chile´s Lake's (10^{th}) Region (see Attachment 1). This site is located in the southern Coastal Range of the Valdivian Temperate Rain Forests Ecoregion (a WWF classification), and is considered a priority area for biodiversity conservation both nationally and internationally.[3]

4. In 1995, Celulosa Arauco y Constitución (CELCO), presented a proposal to build a Kraft-bleached pulp plant with an annual production capacity of 550,000 tons, 50 km northeast of Valdivia and 32 km upstream from the Carlos Anwandter Nature Sanctuary. CELCO is a subsidiary of the Chilean multinational timber company Forestal Arauco, and one of the world´s ten largest producers of market pulp. The total forestry project investment by Arauco in this project was $1.2 billion, of which US$700 million corresponds to the mill itself.[4] The project received its environmental permit in 1998 following considerable controversy.

5. The Sanctuary's degradation, including the massive black-necked swan die-off and migration, has caused tremendous public controversy in Chile, building up during the course of a long, complicated review of the plant´s environmental permit. It has also generated a broad-based, spontaneous citizen´s movement, centered around the group *Acción por los Cisnes* (Action for the Swans), which, over a year-long campaign has played a key role in bringing attention to this issue at the regional and national levels.

6. After a series of citations and fines, court cases, resignation of the company´s CEO, and two plant closures in the first half of 2005, CELCO re-opened the plant in late July 2005, with new restrictions to its environmental permit. However, the final arrangement for disposing of the plant's waste without continuing harm to the wetlands remains an open question, as does the capacity of the wetlands to recover over time.[5]

7. Following the second re-opening of the plant, WWF International undertook an evaluation of: a) the current situation involving the Carlos Anwandter Nature Sanctuary; b) the contamination causes and effects in the wetland; c) the broader consequences for wildlife, ecosystems, and people in the region; and d) the possible solutions and corrective measures. This evaluation included two visits by a WWF International Mission to the city and province of Valdivia, and to Santiago. The first visit occurred August 28 to September 2, 2005, involving Clifton Curtis, Director of WWF International's Global Toxics Program, and Delmar Blasco, former Secretary General of the Ramsar Convention on Wetlands; and the second took place October 24-29, 2005, involving Rune Leithe-Eriksen, Executive Director, Ecology and Pioneering, a specialist on pulp technologies, standards, and practices; and forest products. David Tecklin, Coordinator of WWF Chile's Valdivian Ecoregion Program, facilitated and participated in both visits. During the visits, the experts met with numerous stakeholders in both the Valdivia sub-region and Santiago, visited the CELCO plant, and had opportunities to observe the Sanctuary together with local experts by boat as well as through an overflight.

8. Despite diverse and extensive meetings, as well as the Mission's efforts to listen to the full range of views, and to evaluate carefully the existing data, reports and declarations, it has not been possible to form a comprehensive and complete opinion regarding the pollution events and the rapid process of ecological change in the site. Nor does the Mission pretend to be in a position to offer definitive solutions to resolve the wetland's problems –and the socio-economic issues related to them– given that the requisite information and analyses needed to resolve the situation in an ecologically and socially responsible manner does not yet exist. Additional research and collaborative discussions are required on numerous issues, and these need to occur in the near- and medium-terms.

9. In July 2005, when regional authorities modified CELCO´s permit, they proposed five new activities to address the crisis situation, including an ecotoxicological monitoring project, a new (secondary) water quality regulation specific to the Cruces River, preparation of an environmental management plan for the Cruces River basin, and enhanced enforcement.[6] In general, these are positive steps, but far more decisive and comprehensive action is required and at a much more rapid pace than has occurred to date. Anything short of this will be unsuccessful in reverting the crisis. A series of urgent measures are needed: a) to prevent further deterioration of the wetlands, as well as adjacent ecosystems; b) to help mitigate the damage and restore these areas; and c) to help rebuild trust and confidence that environment and development conflicts such as this one will not be repeated, and that they instead will be addressed in an ecologically responsible and socially equitable manner.

10. The following twenty-five (25) Findings, explained and reinforced by supporting text, provide observations and conclusions regarding the existing situation, as well as recommendations to resolve more effectively the outstanding issues. The Findings are not prioritized, and the subject groupings merely reflect areas of emphasis, although numerous Findings are pertinent to more than one of those groupings.

Findings and Recommendations

Part I. Ecological Impacts and Needed Actions

Finding 1. Status of Sanctuary/Wetland: The site´s conservation values have been seriously degraded, with catastrophic loss of waterbird species, extensive reduction in aquatic plants, and an overall decline in water quality.

11. These wetlands originated with the 1960 earthquake and tsunami that triggered the sinking and flooding of extensive areas surrounding the Cruces River. These have since been colonized gradually by aquatic plants and riparian vegetation, creating different habitat types that are home to a diverse complement of fauna, particularly avifauna, of which at least 119 species have been registered for the site. [7] In addition to the diversity of species, the spectacular abundance of avifauna was once an outstanding characteristic of this site.

12. An ensemble of species in the wetlands relied in large part on the aquatic plant *luchecillo* (*Egeria densa*), a species originally from Brazil, which was present in a large proportion of the wetland and served as a major food source for a variety of herbivorous species, including the black-necked swan, spot-flanked gallinule (*Gallinula melanops*) red-gartered coot *(Fulica armillata),* white-winged coot *(Fulica leucoptera*), red fronted coot (*Fulica rufifrons*), and coipo *(Myocastor coipus*).[8] During 2004, the *luchecillo* dessapeared from 95% of the area that it previously covered.[9]

13. The most emblematic species of the Cruces River was the black-necked swan, whose population increased steadily after establishment of the Sanctuary, due to protection from hunting, a stable food source and the relative abundance of nesting sites**.** Before the catastrophic changes in 2004, the Cruces River Sanctuary has thus been the most important reproductive site for the species in Chile, and possibly for its entire Southern Cone distribution.[10]

14. This species is listed as “vulnerable” to extinction in Chile. From an average of approximately 5,000 swans present during 2003 in the Cruces River Sanctuary and surrounding areas, the population plummeted to around 220 individuals remaining in the wetlands (as of April 2005 according to UACh data).[11] Beyond the direct mortality (estimated at from 300 to 1,000 swans) and emigration of individuals, the loss of these wetlands as a reproduction site is possibly the greatest ecological impact, as underlined by the total absence of nesting in 2004 and 2005. In addition to the collapse of the black-necked swan population, other even more abundant bird species including gallinules and coots have seen equally sharp population declines and similar symptoms of increased parasitism and disease (see Attachment #2).[12]

15. Beyond the more evident impacts to bird species, the ecosystem as a whole has suffered a process of ecological deterioration, including an overall decline in water quality notable in changes in color in the Cruces River, and even in the Cau Cau and Calle Calle Rivers as a result of tidal influences in the estuary system. It is evident that the impacts have surpassed the wetland´s tolerance threshold and have deteriorated enormously the conservation value of this globally important Ramsar site.[13] This conclusion was reinforced by the Mission´s visit to the wetlands, together with researchers from the UACh, where virtually no birdlife was observed in the main stem of the Cruces River.

16. The wetland is fed both by the Cruces River and other small rivers flowing from the Coastal Range, and also experiences a strong tidal influence, such that the mixture of fresh and saltwater from the surface to bottom as well as from upper to lower reaches is affected by tides, climatic conditions and seasonal stream

flows.[14] The temporal fluctuations in water quality and quantity, as well as overall patterns of circulation, are critical elements in shaping the wetland's response to contamination and disturbances.

17. In meetings with local indigenous communities, the Mission also saw the impacts that the collapse of the aquatic system and the presence of aerial and water pollution has had on the incomes, well-being and traditions of the communities that depend directly or indirectly on this ecosystem. Thus, a number of ecosystem services such as irrigation water, tourism potential, aesthetic values, and sense of identity have been impaired. Pollution related health risks remain a major public conern in the region.

Finding 2. Comprehensive and Reliable Monitoring: There is broad consensus that a comprehensive and efficient monitoring system, capable of detecting in a timely manner pollution events and impacts in the wetlands and changes in the ecosystem, needs to be implemented as soon as possible.

18. The need for improved monitoring applies at the plant level as well as for effects in surrounding ecosystems. Pollutants of concern must be monitored to obtain reliable information on the quality of ambient air and water. Such information is a necessary part of any environmental management system,. It provides a basis for informed decision making and the development of environmental management strategies. To ensure that decisions are made on a sound basis, it is essential to be confident that data collection is of adequate frequency, scope and quality.[15]

19. Monitoring of pulp mill operations: The most critical period for monitoring and corrective action is normally the first year of plant operation. This is the period of highest risk as personnel are trained, operational problems are resolved and equipment is calibrated. For this reason, more frequent sampling is required during this start-up phase. Once a record of consistent performance has been established, sampling should at a bare minimum, comply with the World Bank guidelines for the pulp sector (see Attachments 4 and 5), and given the sensitivity of the recipient water body, should be more advanced in this case. Liquid effluents should be monitored for the listed parameters at least daily, or more often when there are significant process changes. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken in a timely fashion. Records of monitoring results should be kept and reported to the responsible authorities. [16]

20. It should be noted, however, that in this case, there was inadequate monitoring prior to, and after, CELCO opened its Valdivia plant by both the company and responsible authorities. Apparently, there was no overall analysis available of plant compliance with its permit during construction or for the first six months of operation.[17] As discussed in more detail in Part IV below, governmental capacity for collecting and analyzing data was low during the first year of plant operation, particularly when compared to the size of the private investment.

21. Normally there should be a comprehensive baseline pre-operational study of the distribution, abundance and diversity of aquatic plants and animals, and of their seasonal and interannual changes, as well as the condition of sediments in the probable zone of influence of plant emissions. This should be conducted no more than two years before start up.[18] These conditions were only partially achieved in CELCO´s environmental impact assessment (EIA), which was not updated between approval in 1998 and construction in 2003.

22. Monitoring of air emissions: Monitoring for opacity (maximum level of 10%) should be continuous; daily monitoring should be conducted for hydrogen sulfide and annual monitoring for other pollutants (Attachment 5).

23. Monitoring of water impacts: Water quality monitoring should include at a minimum monthly testing of groundwater and drinking supplies; establishment of at least two monitoring sites upstream; and three downstream from the CELCO plant. It is particularly worrying that the upstream site may have been compromised by run off from the plant's solid waste dump when the liner was breached, and also that the location of all downstream sites was not yet established at the time of this Mission. In addition, monthly monitoring should occur in fish and sediments for dioxins, furans, heavy metals and phenols as well as reproduction tests for primary and secondary consumers. The Guidelines of the Organization for Economic Cooperation and Development (OECD) for such tests are developed and will soon be available. If no detectable levels are found after three years of start-up, the frequency of monitoring could be reduced. It is a normal procedure that biological tests of the discharge water are performed continuously following standardized eco toxicological procedures. Continuous on-line monitoring of discharge water should include at least BOD, COD, AOX, Ph, TSS, colour, conductivity, temperature, chlorate, N and P.

24. The CONAMA has recently secured support from the Regional Environmental Commission (COREMA) to carry out an "Ecotoxicological monitoring study of pollutants in the Cruces River". The development and financing of this project could be an important contribution toward dealing properly with the disaster, as long as the criteria of efficiency, independence, transparency and credibility are applied both to the selection and supervision of research groups and implementation of the project itself. Nonetheless, the absence of an independent monitoring program throughout most of 2004 and 2005 leaves an important data gap.

25. Monitoring of dioxins: The fact that Chile has no laboratories capable of testing for dioxins is a fundamental weakness in the country´s monitoring capacity, particularly given that it is well known that the pulp sector and other production processes generate dioxins. Investment in these facilities should be an urgent priority for government and the private sector, particularly given the country's commitments under the Stockholm Convention (see Part V below).

26. All monitoring data available prior to the start-up of the CELCO plant as well as during and after, should be compiled and made available on-line to all parties including the public. While CONAMA has made significant progress in making information available by internet, this remains inadequate, particularly given the level of public concern generated by this project.

Finding 3. Scientific Research: Further scientific research is urgently needed in order to bridge the substantial and disturbing gap between available information and the knowledge needed for responsible decision making related to the plant´s impact, as well as the current state and trends in the Cruces River system.

27. This Mission was highly impressed by the scope and quality of research by the Austral University of Chile team who have conducted the only publicly available field investigation into the causes of the crisis, especially given the limited resources available. Nonetheless, the level of basic scientific information on the current status and ecological processes in the wetlands is extremely limited, and despite the 2004 disaster the Mission saw little indication that the authorities or the institutions that fund scientific research were giving priority to filling the knowledge gap on the Sanctuary (with the exception of resources dedicated to this by individual researchers). The limitations in available resources for further research is of particular concern since it implies delays in data collection and analysis at a time when it is crucial for the understanding and recovery of the site. The development of a comprehensive research agenda for the site and of public and private funding to carry this out is thus an urgent and high priority.

Finding 4. Sanctuary Restoration and Funding: There is broad consensus among stakeholders that a comprehensive Sanctuary restoration plan needs to be developed and implemented immediately. In parallel therewith, the Government should establish an independently-managed Sanctuary Fund to finance the recovery and protection of the site over the medium- and longer-term.

28. A plan should be developed to restore the ecological functions of the site, including special measures to recover populations of birds that have disappeared or diminished at the site, based on a scientific understanding of their habitat requirements, behavior and population dynamics. This plan should include analyses of roles and capacities of regional institutions in implementation as well as costs and funding sources.

29. The Chilean Government should consider establishing a Carlos Anwandter Sanctuary Fund to finance the recovery and protection of the site over the medium-term. This is an important measure due to the concern that current ad hoc funding allocated by the state (regional and national governments) as a response to the crisis may not be sustained over time, particularly once the crisis atmosphere is over, whereas the ecological problems will require many years of investment to address. Contributions to this fund could be solicited from various sources including those who use the ecosystem services provided by the aquatic system and/or those who have damaged them. In this sense, CELCO, which is estimated to contribute the vast majority of the toxic discharges into the site, should provide the majority of funding. This should be managed according to international standards in terms of guaranteeing transparency and independence to avoid the possibility or appearance of conflicts of interest, or improper influence.

30. The Conservation Finance Alliance (CFA) is an useful source of information and advice on different types of conservation funding approaches that could be used in designing a strategy for funding the recovery and long term conservation of the Sanctuary. (See http://www.conservationfinance.org/)

Finding 5. Integrated Management Plan: The site requires a comprehensive, integrated management plan, which should be linked to the adoption of the National Wetland Strategy.

31. Government agencies, such as the Corporación Nacional Forestal (CONAF), the Servicio Agrícola y Ganadero (SAG) and the Comisión Nacional de Medio Ambiente (CONAMA), have prepared a proposal to develop an integrated management plan for the Cruces River, but apparently this has only been partially funded, and its start up has been controversial. This plan is critically needed and should have been completed by now. This would facilitate coordination of monitoring, short- and long-term research, technological and other technical advances, community and citizen group matters, land use activities, water management and other environmental permitting decisions.

32. The Chilean Government's completion of a National Wetland Strategy with adequate consideration for the recovery and protection of affected Ramsar sites and other wetlands would be an important step in resolving the current situation and preventing future similar occurrences. The draft of the Strategy was completed several years ago, but it has not been formally adopted. The issue should be taken up at the appropriate levels of government as a priority matter and the draft revised in line with the most recent guidance provided by the Ramsar Convention on issues of management planning, community involvement, inventory and monitoring, integrated coastal zone management, law and institutions, restoration, river basin management, allocation and management of water, wise use, and education, communication and public awareness. Plans should be made to allocate resources for the implementation of the Strategy once formally adopted.

33. The Ramsar Convention has formally adopted detailed guidelines that have now been published as part of the series of the *Ramsar Handbooks on the Wise Use of Wetlands* which could provide useful orientation for the development of the Cruces River management plan.[19]

Part II. Impacts on Human Well-Being

Finding 6. Human/Local Community Impacts: A detailed assessment of the socioeconomic, cultural and potential health impacts in affected local communities and the implementation of mitigation measures are urgently needed.

34. A visit to the indigenous Mapuche community of Tralcao, which lives on the edge of the Sanctuary and supports itself by cultivating the land thirty kilometers downstream from the CELCO plant, highlighted the precariousness of the situation for communities in the area. There is a strong sense of anxiety, disempowerment, and defenselessness in the community following the air and water pollution events, and the ecological collapse in the Sanctuary.

35. Community members reported considerable harm to their livelihoods including the ruin of an agro-tourism initiative, the loss of irrigation water, and harm to current and potential markets for their agricultural products. They also manifested fears about health impacts and potential contamination of potable water supplies, and spoke of the socio-cultural damage being inflicted on their traditional way of life, which they encapsulated in the question: "Will our children be able to continue earning a living from the land?" A large proportion of the population in this area are indigenous Mapuche people, and the lack of consultation with indigenous organizations when the plant was evaluated, and in the subsequent series of regulatory actions--as required in Chile´s indigenous law--constitutes a problem that should be remedied rapidly.[20]

36. In the City of Valdivia, tour boat operators report dramatic declines in visitors and revenue in 2005, and overall tourism visitation to Valdivia has apparently also suffered.

37. To date, neither CELCO nor the government, has conducted evaluations of economic impacts from the disaster or considered compensation measures for local communities directly impacted by the disaster. The issue is being left to the courts to determine, which could take many years to resolve all of the cases.

38. Public controversy and government concern has also focused on the economic impacts of closing, either temporarily or definitively, the CELCO plant. The plant generates 258 direct jobs, and according to CELCO approximately 4,000 indirect jobs.[21] However, the information on indirect employment has never been verified or studied independently and has been controversial. Unfortunately, there are no studies on the overall economic impacts of the plant in the regional economy. A comprehensive cost-benefit analysis that incorporates the impact on other sectors is an important element missing from the current debate.

Finding 7. Confidence Re-building and high-level oversight: Given the extent to which this case has undermined public confidence in the environmental regulatory system, it will be necessary for both national and regional authorities and CELCO to take a series of special, concerted measures that go beyond actions taken to date. In particular, this could include establishment by the President of Chile of a high-level, multi-stakeholder Carlos Anwandter Sanctuary Advisory Task Force, to review and advise on actions, plans, studies and other matters concerning the recovery and long-term protection of the Cruces River system.

39. The CELCO paper pulp plant was presented originally as a clean, low risk and pollution-free project; the subsequent air pollution problems and the deterioration of the Sanctuary have therefore been shocking. This situation has undermined public confidence in the company, the pulp sector as a whole, the courts, and the environmental regulatory system, as demonstrated by recent opinion polls and press accounts.[22] President Ricardo Lagos framed the issue even more broadly, noting some months ago that the company had "damaged the country's credibility".[23]

40. Regrettably, a strong climate of suspicion has been created among key stakeholders. The issue of credibility, and need for confidence re-building, applies to the company's intentions and to the standards of the regulatory system, and requires actions that will help to recover trust in the system, reduce levels of polarization, and facilitate the effective implementation of national and international environment laws and regulations. In so doing, actions which do not take into account all of the relevant stakeholders will not contribute to the restoration of public confidence. It could be important to retain expert, independent advice on conflict resolution in order to manage a process that could lead to positive outcomes.

41. A high-level Task Force could contribute to ensuring the adequate coordination of diverse activities related to the Sanctuary, ensure adequate progress is made, and restore confidence in the regulatory system. This could serve for a defined period, and meet 2-3 times a year to review progress or lack thereof. It could include prestigious political leaders, citizens, and scientists and be staffed by 2-3 full-time staff whose responsibility would be to monitor work that is being done or needs to be accomplished, whether it be by the government, CELCO, scientists, NGOs, communities, or others. Advisors for this body could be comprised to represent diverse sectors including NGOs, government, private sector, universities, labor and local communities. The Task Force need not be charged with undertaking the necessary work itself, but rather with reviewing and facilitating the work conducted by the relevant public agencies and other stakeholders.

Finding 8. Transparent, Participatory Decision-Making: In order to achieve a restoration of confidence, it also will be necessary to ensure that mitigation, monitoring, management, financing and compensation actions are transparent and participatory.

42. These are crucial elements, as well, in regaining public trust in the private sector and the environmental regulatory system. A wide range of standards, mechanisms, and international case studies is available to help guide this process.

43. Public participation in environmental matters is defined by several pillars that involve the important issue of access: to information; to decision-making, and to justice.[24] For the first, it means that the public should be able to obtain environmental information with only limited, explicitly defined exceptions; for the second, that the public should be able to participate in the environmental decision-making process and have its input taken into account; and for the third, that individuals and groups should have opportunities for redress when authorities fail to comply with their duties to provide access to information or decision-making. As per Principle 10 of the 1992 Rio Declaration on Environment and Development,[25] governments agreed to facilitate and encourage public awareness and participation in environmental issues, and to provide effective access to judicial and administrative remedies.

44. The Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters represents the most advanced articulation of Principle 10 in a multilateral environmental agreement (MEA) It provides the public and NGOs in member states with tools and standards than enable them to monitor performance and participate in decision-making. While it has not

been ratified by Chile, since its geographic focus is Europe, as Kofi Annan, the Secretary-General of the United Nations, has approvingly noted that:

> the significance of the Aarhus Convention is global. It is by far the most impressive elaboration of Principle 10 of the Rio Declaration, which stresses the need for citizen's participation in the environmental issues and for access to information on the environment held by public authorities.[26]

45. All of the major MEAs involving chemicals issues, to which Chile is a party to, include significant opportunities for the public to obtain information about their proceedings and decision-making. Participation rules are addressed in formal "rules of procedure" and are elaborated through understandings based on prior practice – practice which has increasingly opened the doors of formerly closed "contact" or "negotiating" working groups in an effort to ensure greater transparency in their decision-making processes. In the context of the Sanctuary, where a wide range of interested stakeholders are both interested in and affected by important decisions being made by CONAMA, COREMA, and other official bodies, every effort should be made to ensure that those processes are participatory and transparent.

46. Two Resolutions of the Ramsar Convention of the Parties (COP) could be of particular relevance to initiating a participatory process in the management of the Sanctuary: Resolution VII.8 on *Guidelines for establishing and strengthening local communities' and indigenous people's participation in the management of wetlands,* and Resolution VIII.36 on *Participatory Environmental Management (PEM) as a tool for management and wise use of wetlands.*[27]

Part III. Celulosa Arauco y Constitución (CELCO)

Finding 9. Operations in the start-up phase carry high environmental risks and were carried out with little attention to environmental impacts, insufficient controls, and totally inadequate monitoring. There are indications that problems in this phase during 2004 resulted in important pollution events which in turn were not adequately reported or monitored.

47. Given the size and complexity of establishing a "Greenfield" pulp mill, it is a normal procedure that both pre-feasibility and feasibility studies are performed. A pre-feasibility study would include technical and site planning for the mill (including alternative sites), determining the necessary road and rail infrastructure, examining the availability of energy and water, and studying housing requirements and employee recruitment and training as well as environmental and social effects of all options.[28] A careful pre-feasibility study would have recognized the sensitivity of the recipient water body. Key issues evaluated should have included the relatively small size of the Cruces River, the major temporal variations in both water volume and circulation, the importance of water bird populations, and the international protected status of the Cruces River under the Ramsar Convention, with its resulting obligations concerning the protection of the ecological character of the site.

48. This did not happen, and a basic siting error occurred where considerations relating to the supply base and transport infrastructure dominated over environmental concerns in deciding on plant location. Once this took place, given the value and sensitivity of the recipient environment only the most effective and advanced environmental technology should have been mandated and installed. And especially during the start-up period, extreme care should have been exercised to reduce risks and decrease adverse effects on the environment.

49. The start-up period of a pulp plant is the most critical time in terms of risks to the environment and safety of the workers; this period is normally 10-12 months. This is where the staff, normally trained in advance, and the machinery are tested. This period necessarily involves several starts and stops, and upset conditions which can be more frequent for short periods of time. During these upset conditions the toxic load on the treatment plant can cause the breakdown of active bacteria. To avoid this, effluent is often directed either to a spill pond or directly to the recipient environment, or the mill is closed. In any case, process effluent has to be dealt with in some way to be able to restart the process. In many mills there are situations where discharges are released directly into the recipient environment, particularly in this start-up phase.

50. It is most likely that it was not the continuous discharges of controlled effluents based on the permitted levels, but accidental uncontrolled heavy discharges of untreated waste water during the early phases of production that were a critical contribution to the alarming situation at the Carlos Anwandter Nature Sanctuary. The lack of adequate monitoring programs and procedures to deal with accidents would have made this possible. The extent to which additional continuous discharges of controlled effluents, within permitted levels, will contribute to wetland ecosystem deterioration depends on many site-specific factors. This impact cannot be judged simply by comparing effluent parameters with other plants, but is a question of the particular sensitivity and characteristics of the Cruces River ecosystem to the types and volumes of contaminants produced.

51. From the analysis of data and earlier consultant reports, it appears that several problems causing emergency discharges have occurred during the start up period of the CELCO plant.[29] Monitoring information shows evidence of peak pollution events in the first six months of operation, which violated national pollution regulations in some cases. Some of these are related to the bleaching process and others to the tertiary (chemical) treatment plant. In this second category, CELCO has released substantial volumes of aluminium sulphate generated in the chemical treatment process. The UACh study concluded that this was one of the principal impacts on the Cruces River system, as in the water column it had the function of precipitating iron onto the aquatic plants in lethal quantities.

52. Use of chlorine dioxide, the basis of Elemental Chlorine Free (ECF) bleaching, leads to problems of chlorate production which could also have contributed to changes in the ecosystem. Chlorate is a powerful herbicide which can seriously affect higher plant life. Brown algae ecosystems in the Baltic Sea have been studied to document the effects of chlorate in kraft pulp mill effluent. The coastal area there was subjected to pulp mill effluent containing high levels of chlorate and there were adverse effects on local algal communities. The main species studied was *fucus vesiculosus*, a common, ecologically significant, large brown alga. Removal of the chlorate from the effluent resulted in the re-colonization of the sites by the brown algae. [30]

53. The CELCO mill monitoring reports show periods of high chlorate levels in the effluent, exceeding allowed parameters in both 2004 and 2005. In addition, chlorate is not captured in the tertiary treatment. Start-up problems resulting in uncontrolled discharges, including chlorate, on several occasions, would affect the recipient environment, and provides another plausible explanation for the loss of aquatic plants downstream from the CELCO plant. A single major pollution espisode can be enough to wipe out plant life. Discharges of other chemical components like black liquor can have the same effects on plant life.[31] Given weaknesses in the monitoring system, it is unclear if black liquor discharges have occurred or not. However, a range of other contaminants were also released into the wetland during this period, at times violating the regulatory norms. Thus, determining exact chemical interactions and sequences of events is extremely complicated in retrospect, particularly given deficiencies in the monitoring program.

Finding 10. Bleaching Process: CELCO´s Valdivia plant, if it continues to operate on the current site, should use a Totally Chlorine Free (TCF) pulp bleaching process, rather than Elemental Chlorine Free (ECF) process, and the TCF bleaching should be combined with closed-loop processes for premium environmental performance.

54. During the last ten years, the technological development related to paper pulp mills has been enormous, not only from the point of view of processes but also concerning environmental protection standards. In this case, the long gap between plant design in 1995 and construction in 2003-4 resulted in a situation where reliance on outdated knowledge led to the use of less environmentally advanced technology, particularly in the bleaching process and also to some extent in the treatment plant. The low technological level was a result of weak environmental regulations which did not require state-of-the-art environmental technology.

55. The bleaching stage is perhaps the most environmentally problematic element of a bleached kraft pulp mill. Large amounts of chemicals are produced and used, and it is often the only part of the mill with a permanent effluent flow.

56. ECF bleaching has been the dominant method in the industry for the past 10-15 years, but it is definitely not a cutting-edge, state-of-the art technology and practice for purposes of ensuring protection of the environment. Decisions to introduce ECF bleaching in modern pulp mills are often based on out-dated knowledge and assumptions about pulp quality, and such was the case in CELCO´s Valdivia plant. In fact, since the introduction of TCF bleaching in the early 90's, technical development has made it possible to reach the same quality and brightness in paper pulp as with chlorine dioxide bleaching.[32]

57. TCF bleaching technology should have been used from beginning for the Valdivia plant, especially given the sensitivity of the recipient environment, and it should be introduced as soon as feasible to this plant. The TCF approach has several advantages in reducing environmental risk. TCF bleaching produces no AOX or chlorinated compounds, and it also reduces discharges of other hazardous compounds.

58. In relation to the ECF technology, it should be noted that all bleaching chemicals are potent oxidisers, and as a result they present hazards to workers and nearby residents. When compared over a full range of characteristics, oxygen-based chemicals are less dangerous overall than chlorine dioxide (ClO_2).[33] Both chronic and acute toxic effects can result from ClO_2 exposure including irritation of the eyes, nose, and throat, coughing, wheezing and breathing difficulties (possibly delayed), pulmonary edema, possible chronic bronchitis and asthma.[34] This, along with the chloroform and similar by-products from ECF bleaching, contribute to the hazard profile of chlorine dioxide. [35]

59. In addition to the on-site work hazards, chlorine dioxide can present a significant danger to communities living near mills.[36] Although until recently pulp companies maintained that dioxin could not be created or formed in this limited part of the process, recent research at pulp mill sites found dioxins in residues from the production of chlorine dioxide in three mill locations in Sweden. Importantly, all of these mills have systems supplied by Eka Chemicals, the same company that supplies the CELCO plant. [37]

60. For more than ten years, pulp companies have stated that the ECF process does not result in significant discharge of dioxins into the environment as a result of improved processes and bleaching methods. However, a new study, released in June 2005, shows increased concentration of dioxins in the Baltic Sea marine environment near ECF pulp plants during 1979-2000. According to the research group, this indicates ongoing pollution rather than leakage from sediments, which was a common hypothesis. The study links the increased dioxin levels with chlorine dioxide bleaching as one possible source. [38] The results

of that study have taken the whole industry by surprise and a new research program has been initiated by the Swedish Environmental Protection Agency and forest industries.

61. The only option to avoid producing, using ClO_2 and discharging its components is to abandon ECF bleaching. This is reaffirmed by the World Bank's Guidelines for the Pulp and Paper Industry, which, since 1998 have identified TCF as the best pulp bleaching option and direct that this should be combined with zero effluent, or closed-loop, processes for premium environmental performance. [39]

62. Several mills in the world produce high quality TCF pulp, and many more are capable of doing so. Many reports support the view that TCF is the best option, specifically from an environmental point of view. The European pulp industry is very interested in the research concerning catalytic bleaching with oxygen gas conducted at the Helsinki Technical University. According to researcher Tuuhla Lehtmaa, there is pressure on the industry to switch to TCF bleaching. Catalytic oxygen gas bleaching would provide the advantages of traditional TCF technology, while being even more cost-effective than ECF.[40]

63. A few modern pulp mills are currently considered leaders from an environmental point of view. These include the Mönsterås and Östrand mills in Sweden, and the Stendal mill in Germany. They all are able to produce 100% high quality TCF bleached pulp. Critics of TCF often mention that there is not a demand for TCF pulp. However, pulp demand is mostly not an issue of ECF versus TCF, but instead one of ensuring high quality pulp with full brightness. This is achievable in a modern TCF mill.

64. CELCO commonly refers to Stendal as its sister mill. It should be mentioned here that the Stendal mill is capable of producing 100% TCF pulp as well as ECF. Stendal also has a more advanced secondary treatment plant, and does not have tertiary (chemical) treatment. In addition, the Stendal mill was built on a former industrial site and discharges its effluent into the River Elbe, a large river that has been polluted by industrial discharges for over one hundred years. That alone, is a major difference from the CELCO mill's siting adjacent to a fragile and internationally recognized wetland/estuary area. The environmental history involving Stendal's siting and operations also includes the pre-existence of a strict water law and a significant monitoring and enforcement capacity in the public agencies, which stands in stark contrast to the Valdivia plant.

65. In addition to discharging zero chlorine products, an additional TCF benefit is the opportunity to implement a Closed Circle (CC) option, which reduces fresh water usage and offers opportunities to nearly eliminate bleach plant wastewater discharge.

Finding 11. Closed Systems: Impact from the CELCO plant could be reduced by closing the loop in its production system and reducing discharge of chlorine products and other waste releases to nearly zero, as well as reducing freshwater usage.

66. Current trends in the environmentally most advanced segment of the industry are towards a totally effluent free (TEF) bleaching process. Effective delignification prior to the pulp bleaching stages minimizes the amount of toxic effluent from bleaching. To meet these requirements, the latest technology has to be introduced. This involves a combination of ozone delignification and TCF bleaching as well as prolonged cooking.[14] With the existing CELCO installation this would not require excessively large investments and rebuilding.

67. In a plant using ECF bleaching, the soluble organic substances removed from the pulp in bleaching stages that use chlorine or chlorine compounds, as well as the substances removed in the subsequent alkaline stages, are chlorinated. Some of these chlorinated organic substances are toxic; they include

dioxins, chlorinated phenols, and many other chemicals. It is generally not practical to recover chlorinated organics in effluents, since the chloride content causes excessive corrosion. The only viable, environmentally safe approach is to introduce TEF bleaching process, in combination with a shift to TCF bleaching as previously recommended.

Finding 12. Industrial liquid waste (ILW) Treatment: If the Valdivia plant is to continue operating, its secondary treatment system should be reconditioned and rebuilt, with tertiary treatment used only as an emergency option.

68. The decision to use tertiary (chemical) treatment at CELCO's Valdivia plant was not appropriate, and is difficult to understand from a technical and environmental point of view. At least the same levels of selected parameters in the effluent could have been obtained by secondary treatment process adjustments, as mentioned below, and proper and effective secondary treatment management. Moreover, chemicals used in pulp production can have environmental effects on the recipient environment, and all chemical stress on that environment, especially when it is as sensitive as the Carlos Anwandter Sanctuary, should be avoided. This includes the large amounts of aluminum sulphate that are used in the tertiary treatment, which is suspected by key scientific findings to be a principal cause in the die-off of the aquatic plant (luchecillo) in the Sanctuary.[41]

69. Biological treatment systems, such as activated sludge, aerated lagoons, and anaerobic fermentation, can reduce BOD by over 99% and achieve a COD reduction of 50% to 90%. These systems are used worldwide in modern pulp mills. The future in secondary treatment is to minimize the effluent from the bleaching process, decrease the production of sludge and to combine a high COD reduction with low nutrient discharges.

70. This has been recognized by the SCA Östrand mill in Sweden. By minimizing the water usage, they succeeded in closing the bleaching process far more than had previously been possible, and as a result they were able to build the most modern treatment plant, Multibio. By minimizing the water usage, and by using only TCF bleaching and the installation of the Multibio system, the engineers were able to make the secondary treatment plant more compact, as well as less sensitive to process disruptions. The result has been a cost of operation that is lower than traditional treatment, as well as less sludge production. In addition, the lowest levels of water consumption can be reached only with the TCF process.

71. CELCO's secondary treatment plant should be reconditioned and rebuilt with state-of-the-art technology from an environmental point of view, which would provide greater security in emergency situations and achieve higher parameters than current tertiary treatment. Tertiary treatment could be considered an emergency option only. Tertiary treatment is not a common technique used in modern pulp mills. The reasons are mainly two: a) it is an expensive technique, with the cost of the chemicals being high; and b) it produces large amounts of sludge, which also is expensive and complicated to handle, since the sludge has to be treated as toxic waste. Improperly managed, as appears to be the case here, tertiary treatment increases the overall chemical load on the environment (in this case aluminum sulphate). It should be mentioned that tertiary treatment is not seen as a Best Available Technology (BAT). [42] Only one installation in a modern mill using tertiary treatment has been found, namely Varkaus in Finland. The few other mills using tertiary treatment are in Japan, and were retrofitted with this technology in large part in order to manage effluent colour.

Finding 13. Solid Waste Management System: The CELCO Valdivia plant's solid waste management controls are deficient and in need of significant improvements to ensure full and adequate control over the wastes, which would strengthen environmental protection and safety for workers.

72. Solid waste management is normally a major concern in modern mills. Regrettably, this is not what our Mission found at the CELCO mill. Full control over solid waste streams at final deposition was lacking and should be implemented.

73. Solid waste is defined as material that is removed from use and disposed of. Solid waste consists of mechanical, biological, and chemical sludge from wastewater treatment plants; dust and slag from boilers; dregs from green and white liquor in the chemical recovery system; lime mud and bark from wood handling; and organic and inorganic waste from the whole operation. Solid waste is mainly produced by primary and secondary treatment of effluents.[43] As noted above, the tertiary treatment system in the Valdivia plant also increases overall waste volumes substantially.

74. The small quantity of *hazardous waste* normally produced in pulp mills should be removed by certified contractors, and its disposal should follow well-defined routes for elimination. Examples of these types of hazardous wastes are used oils, dye spillage and filter materials. When the WWF Mission's pulp expert visited the Valdivia mill, it was recognized that filter ashes were dumped uncontrolled and spread by the wind, affecting workers as well as the surrounding workplace and the broader environment. This is absolutely unacceptable as filter ashes might contain dioxins and other highly toxic components.

75. Hazardous waste should be identified and stored in separated places to ensure complete control. From the plant report that was available, it appears that little or no identification and separation of hazardous waste is being implemented to minimize risks to the environment as well as to workers and inhabitants in the area. In general, the Mission´s pulp mill expert observed that in general, hazardous waste had not been considered important from an environmental, or workers' safety, point of view.

76. Mixing all kinds of waste is not acceptable. Doing so increases the amount and the area needed to manage the waste. The size of the dumpsite should be planned according to production for at least 50 years, whereas the CELCO Valdidia plant dumpsite was designed for only 10 years. As a consequence, the developed and lined area is already close to full, and the site is being expanded after less than two years of plant operation.

77. Moreover, monitoring of leached water from the dumpsite should be a part of the waste management plan. On a yearly basis, four tests over a two month period should be carried out. This should include analysis of heavy metals, pH, Phenols, COD, BOD, TOC 15, EGOM, EOX 16, nutrients, salts and conductivity. Also flows as well as toxicity tests such as Microtox should be made.

78. An additional area of concern is the air pollution and management of residues from filters as well as installations to capture air emissions. This has not been looked into by our Mission, but should be seen as important and included in the waste management plan.

Finding 14. CELCO Responsibility: Consistent with evolving applications of the precautionary principle (see Finding 23, below), CELCO needs to assume responsibility for proving the safety of its action in relation to the Sanctuary, rather than leaving it to others to show harm (reversed burden of proof); and for bearing the full environmental and social costs of their activities, with those costs reflected in the market price for goods and services.

79. The precautionary approach or principle calls for rigorous scientific research on chemical hazards and safe substitutes or alternatives. It challenges us to design alternatives that address societal needs without harmful consequences. In that context, the costs associated with the assessment should be borne by the company or companies that stand to profit from the use of particular technologies, chemicals or others

substances in producing pulp or whatever product that might be at issue. Pursuant to long-standing formulations of precaution, including the 1998 Wingspread Statement,[44] it is reasonable to expect that responsible parties (not governments or the public) will bear the burden of producing needed information. This is particularly true for chemicals, such as dioxins – a by-product chemical associated with the Valdivia pulp production – that is hazardous, bioaccumulative and persistent.[45] At minimum, it should be up to the company to show that chemicals in question are safe, or that the societal benefits are so great as to necessitate production and use.

80 In this regard, Agenda 21[46] as agreed by consensus by governments at the Earth Summit in Rio de Janeiro in June 1992, identified the elements of the "polluter pays" principle:

> [Incorporation of] environmental costs in the decisions of producers and consumers, to reverse the tendency to treat the environment as a 'free good' and to pass these costs on to other parts of society, or countries, or to future generations; [and]
>
> I]ntegration of social and environmental costs into economic activities, so that prices will appropriately reflect the scarcity and total value of resources and contribute towards the prevention of environmental degradation

81. Given that it requires cost internalization of pollution, the polluter pays principle provides a strong incentive for producers, such as CELCO, to minimize and prevent pollution-causing activities and substances, including through developing less-polluting alternatives. These concepts are reaffirmed in Principle 16 of the Rio Declaration on Environment and Development; in the preambular section of the Stockholm Convention, to which Chile is a Party to, as well as in the outcomes of World Summit on Sustainable Development (WSSD), held in September 2002, which recognizes the need to adopt and implement the polluter pays principle, as described in Principle 16.

82. The "polluter pays principle" is embedded in Chilean environmental law (Ley de Bases del Medio Ambiente, 19.300); however, it does not appear to have been consistently applied in this case, given that nearly all of the funding for response to the crisis has come from the government.

Finding 15. Additional CELCO Responsibility: CELCO's assertions expressed to members of this Mission that it will take actions that exceed existing national regulatory norms, and to commit the necessary human and financial resources to help ensure recovery of the Sanctuary, regardless of the issue of fault in relation to the Sanctuary's devastation, is a step in the right direction, that should be demonstrated through concrete measures.

83. The President of the CELCO´s Board of Directors, Mr. Alberto Etchegaray, and the CELCO CEO, Mr. Matias Domeyko, signaled their committment, in a meeting with this Mission, to taking all necessary measures to prevent further harm to the Sanctuary and to assist in its recovery. The specific measures proposed by the company in this regard should be made public and reported on regularly in order to improve dialogue with all sectors.

84. As a general principle, good neighbor actions are positive, but there should be a direct relationship or correspondence between the company's investment in the community and the negative impacts that have occurred. CELCO's contributions to youth educational scholarships, sponsorship of sports and other expressions of interest in local community development are not a substitute for Sanctuary-related restoration and compensation initiatives, which will require an investment that most likely exceeds by orders of magnitude the company's funded community-level activities.

IV. Regulatory and Policy Considerations

Finding 16. Sanctuary protected area status: Protected area legal status and institutional structure for the wetland area was weak and ambiguous, and contributed to the disaster. The long-standing proposal to designate the Cruces River estuary and wetlands as a National Reserve should be enacted without further delay.

85. Although the area was designated as a Ramsar site in 1981, and National Reserve status was proposed repeatedly and over many years, this was never enacted. The Sanctuary is under the legal jurisdiction of Chile´s National Monuments Council, and administered under an agreement with CONAF. The weak and ambiguous legal status of the Carlos Anwandter Nature Sanctuary´s current form of protection undoubtedly contributed to the ecological disaster as it resulted in limited authority and legal attributions of local personnel, and a fracturing of legal and management responsibilities among different institutions. It is noteworthy that--despite decades of careful monitoring of water bird populations, and the dedication of local personnel to prevent illegal hunting--at the level of local area management there was such limited capacity to address this new form of catastrophic change once it became evident. In order to clarify management responsibilities and strengthen its protection, the Cruces River estuary and wetlands should be designated as a National Reserve without delay.

Finding 17. Weaknesses in the Regulatory Regime: National norms and regulations for hazardous waste disposal, industrial liquid wastes (ILW) and water quality, and for monitoring and enforcement are inadequate to the task of ensuring the environmental safety of the CELCO plant, and their strengthening is an urgent priority.

86. Water quality regulations applied to the plant are generic, and as a result not sufficiently specific to the Cruces River ecosystem. To date, the pollution parameters in national regulations do not adequately consider the sensitivity of the recipient water body and downstream ecosystems. Thus, the parameters that govern the CELCO plant were not established with an understanding of the characteristics of the recipient water body, but rather are generic values which cannot guarantee the maintenance of adequate water quality. As mentioned above, the site's characteristic as a shallow water wetland with strong tidal influences makes it extremely vulnerable to toxic accumulations, this was not adequately taken into account in the original permit (see Attachment 3). The COREMA recognized this issue in its adjustment of the plant permit in June of 2005, and required the development of a "secondary water quality norm" for the Cruces River. This is a positive step, and should be accelerated.

87. The case also highlights a fundamental weakness in the water quality regulations, which regulate only the concentration of effluent rather than the overall pollutant load it carries. Thus, they do not provide an effective tool for restricting contamination, since large amounts of contaminants can be discharged legally as long as effluent is diluted with a sufficient volume of water. In its resolution 377 in June of 2005 (which modified the original permit of the CELCO plant in Valdivia), the COREMA attempts to rectify this evident problem by establishing limits for daily load as well.[47] However, this permit did not adequately stipulate the frequency of monitoring or the mechanism for calculating the parameter. Monitoring information is thus unclear, and there is continued risk of major pollution events passing inadvertently within monthly averages.

88. The government's enforcement capacity has been limited in this and other cases (a finding reinforced by the recent OECD evaluation, as addressed in a later Finding). The CONAMA does not have professionals on staff with experience in pulp technology and pollution issues, and apparently several months passed before the first monitoring report prepared was evaluated by the pertinent authorities. In

addition, enforcement mechanisms have (with the exception of the plant closure in early 2005) been limited to fines which are so low in relation to the overall investment that they do not provide any incentive to comply with the norms. Although the concept of preventing environmental damage is at the core of Chile´s National Environmental Framework Law, the idea of preventive plant closure has been hotly debated in the Region, and has not been consistently supported by the CONAMA or COREMA.

89. A unique and effective enforcement mechanism available in Chile appears to be the Council for the Defense of the State (Consejo de Defensa del Estado or CDE), a para-statal body with responsibility for the legal defense of the state's interests. The CDE is currently suing CELCO at the request of CONAMA for "environmental damage" and seeking substantial remedial measures and compensation.

Finding 18. EIA Process Needs Strengthening: The current national environment impact assessment (EIA) requirements and process for reviewing the adequacy of facilities such as the CELCO mill are inadequate, and need to be modernized and strengthened. In particular, they should include provisions requiring the evaluation of alternatives, with respect to proposed or modified facilities and impacts on recipient environments, without mandating a particular option, e.g., ocean disposal for waste discharges,.

90. As many stakeholders have noted, including Chile's Senate Commission for the Environment and a number of academic groups, the current crisis in the Sanctuary is a manifestation of continuing weaknesses in the country's environmental regulatory system.[48] In order to improve the system, it is necessary to establish a decision-making procedure within the Environmental Impact Assessment System that establishes a clear and direct link between the regulatory measures taken and the best scientific information available such that political influences in this process are reduced to a minimum. In the initial permitting process, the decision to require a chemical treatment process (tertiary treatment) for ILW was evidently not based on the best available technical information or on the industry standard, but on other non-technical considerations. Similarly, political decisions taken by the cabinet ministers overseeing CONAMA eliminated key monitoring safeguards at the company's request, undoubtedly contributing to a lack of preparedness to address pollution impacts.[49]

91. The broader weakness exemplified by this case is that the EIA process does not include an evaluation of viable alternatives, and that the role of the government in the evaluation of a project is limited to its approval, rejection or approval with conditions. Given this situation, projects have almost never been rejected. In addition, there is no legally binding land-use planning or zoning outside of urban areas, which creates a system incapable of addressing even basic siting issues.

92. There is a long standing principle in many environmental frameworks that where high impact activities occur, a comparative analysis of alternatives is required. A plant of this type should never have been allowed at a site adjacent to a wetland recognized as being of international importance for its ecological values, and other alternative sites should have been evaluated.

93. The COREMA has mandated a new EIA for disposal of ILW, an important measure for resolving this issue. Unfortunately, the requirement to deposit ILW in a "water body other than the Cruces River" risks repeating the same errors as have occurred earlier in the process. This is because the demand has been interpreted by the company and most observers as a mandate to build a pipeline to transport ILW directly to the sea, and is apparently the only alternative under consideration. The final destination of the plants effluents should be determined through an adequate analysis of alternatives rather a focus exclusively on the pipeline. One of the long standing maxims of marine pollution scientists is that "dilution is not the solution to pollution", a concept that holds true with regards to the proposed ocean pipeline solution.

94. At a minimum, other options to be evaluated could include relocation of the plant and state-of-the-art technological improvements or some combination of the various options. As a general principal, all alternatives for ILW should consider that only the absolutely lowest possible chemical and biological load on the recipient water body should be accepted.

95. An additional fundamental weakness in the framework is that environmental permits are not time bound and are essentially permanent entitlements. Thus, CELCO built in 2003 and 2004 a plant that was designed in 1995 without any upgrading required by the authorities. This stands in sharp contrast with, for example, the Swedish regulatory system which requires new permits for pulp plants on five year intervals. The fact that permits are permanent, and allow for a project to be postponed indefinitely and then built without upgrading, is certainly a major environmental liability for Chilean society.

96. While there is already considerable experience in Chile with EIAs, the International Association for Impact Assessment (IAIA) could be a useful source for additional information and advice for the next phase of the CELCO Valdivia plant EIA (see http://www.iaia.org/mainindex.htm).

Finding 19. Environmental Guidelines for Pulp Mills: Guidelines should be adopted at the national level in order to ensure protection of the environment from emissions generated by future pulp mills; and to clarify for government agencies, industry and potential investors the minimum environmental requirements of Chile for new and existing installations.

97. The guidelines should have the following key elements, among others:

- Emission limits – defined limits for discharges into water and air, with guidelines as to limits for different recipient bodies.
- Solid waste disposal guidelines.
- Site suitability criteria – meteorological, physical, marine and biological guidelines.
- Monitoring – pre-operational and operational studies required.

98. The guidelines should be reviewed every 5th year to comply with evolving technological developments and operating practices.

V. International Norms and Standards

Finding 20. Ramsar Convention obligations: Chile needs to meet its obligations under the Ramsar Convention on Wetlands[50] to protect its wetlands, including but not limited to expeditiously placing the Carlos Anwandter Sanctuary on the Convention's Montreaux Record.

99. The sanctuary needs to be immediately included by the government in the Montreaux Record, a list maintained by the Ramsar Convention of the sites included in the List of Wetlands of International Importance "where an adverse change in ecological character has occurred, is occurring, or is likely to occur".[51] Given the urgent, devastating situation that currently exists within the Sanctuary, it is not appropriate to wait one year, as indicated by the Government, for further reviews before including the site in the Montreux Record. The inclusion in the Montreux Record should not be viewed as a "black mark" on the country's record, but rather as an expression of Chilean Government´s firm commitment to implementing the Convention in relation to this site. Listing on the Montreux Record, moreover, would enhance the opportunities for generating additional efforts and resources to aid in the site's recovery.

100. Fifty seven Ramsar sites are at present listed in the Montreux Record. Over time, 23 sites have been removed from the record after the authorities concerned have identified and applied corrective measures. This includes sites in countries such as Algeria, Belgium, Bolivia, Germany or Venezuela. (See http://www.ramsar.org/key_montreux_record.htm#remove)

101. In relation to the above recommended action, a recent draft document produced by CONAMA for the discussn of the a new National Policy for Protected Areas, it is recognized that "In cases of emblematic damage to national biodiversity, important gaps have been detected in terms of what is required by international treaties that Chile has signed and the application of national legislation. The case of the Ramsar Convention and our responsibilities within that could be noted. The Policy should define lines of action that allow for the appropriate implementation of commitments undertaken by Chile in the international treaties related to biodiversity."[52]

102. All of the Ramsar Convention's guidance and advice could be brought to bear through a formal Ramsar Advisory Mission (RAM). RAM´s have been sent, at the request of the concerned government, to 53 Ramsar sites, including in countries such as India, Mexico, Spain, Sweden and Uruguay. Although many of these were sites listed on the Montreux Record, this is not a precondition in order to send an advisory mission. It should be noted that what had been considered as a "Ramsar Report" in early 2005 was in fact a report of two independent experts hired by the Government of Chile with the assistance of the Ramsar Secretariat, but not a report of a formally organized RAM.

103. The adoption and effective implementation of a National Wetland Strategy (see Finding 5) would be another key step in the direction of compliance with the Ramsar Convention.

Finding 21. Stockholm Convention Obligations: Compliance with the spirit as well as the letter of the Stockholm Convention on Persistent Organic Pollutants (POPs)[53], requires taking expedited action to address CELCO-related responsibilities involving dioxins, in particular, as well as other chemicals covered by the Convention.

104. Listed under the "industrial source categories [that] have the potential for comparatively high formation and release of these chemicals to the environment," the Stockholm Convention includes the "production of pulp using elemental chlorine or chemicals generating elemental chlorine for bleaching."[54] See concerns related to chlorine dioxide processes, and the lack of testing capacity for dioxins above.

105. Regarding the most toxic pollutants, the Stockholm Convention encourages the use of the best methods available for "the promotion of the recovery and recycling of waste and of substances generated and used in a process." [55] A key point in determining the final destination of the plant's liquid wastes (including the proposed pipeline's viability) emerges in the convention's emphasis that "when considering proposals to construct new facilities or significantly modify existing facilities using processes that release chemicals…priority consideration should be given to alternative processes, techniques or practices that have similar usefulness but which avoid the formation and release of such chemicals," including "process changes that lead to the reduction or elimination of releases, such as moving to closed systems."[56]

Finding 22. Relevant OECD Recommendations: Consistent with the OECD review of Chile's environmental performance which broadly recognizes improvements in environmental policy-making in Chile, but highlights certain remaining weaknesses, recommending that the the Government of

Chile undertake further efforts to adequately protect the country's natural heritage, including but not limited to the Sanctuary, in the face of rapid economic growth.

106. The OECD review of Chile's performance in the field of the environment makes 52 Recommendations to improve the environmental policy and management, including creating an environmental inspectorate and strengthening enforcement; strengthening and developing the Chilean environmental information system; including environmental indicators to support government accountability and public information; adopting a law on the protection of nature and biodiversity; and further improving environmental integration in fast-growing primary sectors (mining, forestry, aquaculture) and in the energy, agriculture, and transport sectors. All these recommendations are consistent with the WWF Mission´s Findings, which were developed without a previous analysis of the OECD report. [57]

Finding 23. Precautionary Principle Committments: As established in Principle 15 of the Rio Declaration on Environment and Development, and embodied in the Stockholm Convention and numerous other international agreements, the precautionary principle/approach needs to be applied much more rigorously in Chile's national environmental and human health regulatory structure.

107. Referred to as the "precautionary principle" or the "precautionary approach," precaution is one of the more prominent and commonly referenced core tenets in international and domestic environmental law. With origins in West Germany in the late 1970s, precaution has evolved as a response to the environmental and human health impacts caused by rapid industrial growth and the inadequacies of pollution control laws. In important respects, it responds to the growing appreciation of the scientific uncertainties associated with environmental degradation, and reflects two important insights: society often can not rely on scientific certainty for determining response measures; and the consequences of not taking preventive measures early enough can be irreversible.[58]

108. Precaution is a fundamental component of most multilateral chemicals and chemicals-related agreements. The Stockholm Convention, which Chile ratified in January 2005, is very explicit, stating that "precaution underlies the concerns of all the Parties and is embedded within" that agreeement.[59] Among its operative provisions, the Convention requires Chile and other Parties that have the ability to assess and regulate new chemicals, to do so with the aim of preventing the production and use of new chemicals that exhibit POPs characteristics. Especially pertinent to the situation involving the Carlos Anwandter Sanctuary, Parties must promote the development and, as appropriate, require the use of substitute or modified materials, products, and processes to prevent the formation and release of POPs.[60] Consistent with these admonitions, the Convention provides that Parties must make decisions about listing additional POPs in the Convention in a "precautionary manner."[61]

109. What the Stockholm Convention and other legal instruments in the area of international chemicals management make clear is that precaution has evolved significantly since the Earth Summit in 1992. As with the Stockholm Convention, it provides an overarching framework for addressing threats from toxic chemicals, responding to a) the complexity of environmental health problems; b) the paucity of information and subsequent uncertainty about cause-effect relationships; and c) the slow pace of testing and government decision-making.[62] At its core, the principle calls for preventive, anticipatory measures to be taken when an activity raises threats of harm to wildlife (e.g., the black-necked swan) and the environment (e.g., the Carlos Anwandter Sanctuary), even if some cause-and-effect relationships are not fully established scientifically.

Finding 24. Convention on Biological Diversity (CBD) Obligations: Consistent with its obligations under the CBD[63], the Chilean Government needs to take explicit steps to restore and protect the Sanctuary, as part of its CBD-related National Biodiversity Strategy and Country Action Plan.

110. To date, nearly 190 governments (including Chile, in September 1994) have ratified the CBD. Chile adopted in 2003 the National Biodiversity Strategy of the Republic of Chile, and more recently, in April 2005, the Country Action Plan for the implementation of the Strategy during the period 2004-2015. The Plan includes a Programme for the Conservation and Wise Use of Wetlands of High Biological Value under International Protection and Fight against Desertification. Thus, it should provide orientation to address the ecological disaster at the Carlos Anwandter Sanctuary and surrounding aquatic system.[64] Given Cruces River designation as a conservation priority area within the regional strategy, special measures should be taken there by CONAMA to ensure full compliance with the Action Plan.

Finding 25. The WSSD's 2010 and 2020 Targets Requires Actions, Now: The Chilean Government needs to take early and effective action to significantly reduce the current rate of biodiversity loss within the country by 2010, and to minimize chemicals-related harm to the environment by 2020, consistent with its commitments as agreed at the Johannesburg World Summit on Sustainable Development in September 2002 (WSSD).

111. In late August/early September 2002, Chile and more than 180 other governments of the world, including many represented at the level of heads of state, participated in the Johannesburg Summit. As part of that 10th anniversary review of the 1992 Earth Summit, special efforts were directed at setting target dates for further actions that were needed to achieve the goals and objectives of that earlier Summit, as well as follow-on initiatives called for during the Johannesburg WSSD gathering. As part of a broader statement on future actions directed at achieving sustainable development, participating governments at the WSSD agreed by consensus to a Plan of Implementation[65] that, with respect to biodiversity and chemicals management:

> [agreed] to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth[66]; and
>
> set a goal that, by 2020, chemicals would be used and produced in ways that lead to the minimization of significant adverse effects on human health and the environment….[67]

112. The 2010 target on biodiversity, now less than 5 years away, requires concerted action on a number of fronts. Clearly, the CBDoffers an excellent framework for taking action to meet this target, and within that Chile needs to use much more effectively its National Biodiversity Strategy and Country Action Plan for 2004-2015, as addressed in the previous Finding.

113. The 2020 target for minimizing harm from chemicals has since been referenced repeatedly in international chemicals-related global fora as providing an overarching goal that should guide actions by all interested parties, including governments, the private sector, and NGOs, among others. As an overarching goal, it is widely acknowledged that its achievement necessitates incremental action, beginning as soon as possible, if there is to be any hope of meeting that target date. Minimizing harm from chemical contaminants, in places like the Carlos Anwandter Sanctuary, is but one of many actions that need to be taken in Chile now and in subsequent years, such that that harm to the environment and to human health, broadly and collectively represented, will have been minimized by year 2020 as agreed at WSSD.

VI. Conclusion

These Findings and Recommendations, while necessarily based on a rapid assessment of the case, are presented with the hope of providing a constructive, forward-looking contribution to address the environmental crisis in the Cuces River estuary and wetlands in the Valdivian Ecoregion of Southern Chile. While there is enormous uncertainty as to how the impacted ecosystem will evolve over time, a concerted and consistent effort by all stakeholders is the only approach with a chance of succeeding in reverting this disaster. In so doing, the result would benefit not only the affected area, but would also send a strong message to Chilean citizens, and to the global community that Chile is resolute in its commitment to protecting its natural heritage.

End Notes:

[1] A "Ramsar Site" is a wetland included by the concerned government in the List of Wetlands of International Importance maintained by the Secretariat of the Convention on Wetlands, also known as the Ramsar Convention after the name of the city of Ramsar, in Iran, where the treaty was signed in 1971. For the complete text of the Convention, see www.ramsar.org

[2] UACh (2005) "Estudio sobre origen de mortalidades y disminución poblacional de aves acuáticas en el Santuario de la Naturaleza Carlos Anwandter, en la provincia de Valdivia." Universidad Austral de Chile, April 2005.

[3] Smith C, J Armesto y C Valdovinos. *Historia, Ecología y Biodiversidad de los Bosques Costeros*. Editorial Universitaria. Santiago, Chile; J Cavelier and D Tecklin, in Smith et al., Ibid;

[4] CELCO´s permit (COREMA X Región resolución N° 279 del año 1998) is for a plant with a capacity of 550,000 tons/year of Kraft bleached pulp. The installed capacity is higher, but there is conflicting information as to the exact production capacity. See also, http://www.plantavaldivia.cl/proyecto.htm.

[5] See COREMA X Región, Resolución de Calificación Ambiental 377, 6 de junio de 2005.

[6] COREMA op cit.

[7] CEA 2003. *Guía de los Humedales del Río Cruces*. Centro de Estudios Agrarios y Ambientales, Valdivia. This book documents the biodiversity of the site, including: 8 amphibian species, 17 fish species, 119 avian species, and 19 mammal species.

[8] CEA 2003, op.cit. Black-Necked Swan (*Cygnus Melancorypha*), Tagüita (*Gallinula melanops*), red forehead Tagua (*Fulica rufifrons*), Common Tagua (*Fulica armillata*), Small Tagua (*Fulica leucoptera*), Coipo (*Myocastor coipus*).

[9] UACh op cit.; UNORCH (Ornithology Union of Chile) News: Research indicates that 80% of the species in Cruces River have decreased in population; Botanist Carlos Ramirez, indicated that luchecillo plant cover has decreased by 95% and that according to historical records, this kind of decrease has never occurred before in the Sanctuary, cited in *La Tercera*, Jun 13 of 2005. (www.unorch.cl/noti2.htm).

[10] UACh op.cit Anexo V; p.409-410; CONAF (2004) Antecedents of Black Neck swans populations and the impact in to the Cruces river wetlands Census, december, 2004; UACh, op.cit, p.409.

[11] UACh op.cit; And direct observations by the WWF Mission.

[12] Species whose populations have collapsed include the taguita or spot flanked gallinue (*Gallinula melanops*) which has declined from approximately 5,000 to a few hundred individuals, and the tagua or red gartered coot (*Fulica amrillata*) which declined from 15,000 to a few hundred individuals UACh, op.cit, p.403 and 414.

[13] UACh, op.cit, Conclusion´s, p. 427. Walter Di Marzio and Rob McInnes (2005) "Misión Consultiva Ramsar: Chile. Informe de la Misión". March 29 to April 4, 2005. p. 30, point 145, and WWF Mission observations.

[14] Pino, M., Perillo, G M. & Santamarin A, P., 1994. Residual fluxes in a cross section in the Valdivia river estuary, Chile. Estuary, Coastal and Shelf Sciences 38: 491-505.

[15] World Bank. 1998. "Pollution Prevention and Abatement Handbook: Pulp and Paper Mills," Technical Background Document, Environmental Department, Washington, D.C.

[16] Op. cit.

[17] An engineering firm hired by CONAMA completed the first overall review of the plant´s compliance with its permit a full eight months after the plant entered into operation. This report found major variances between the permit and plant situation, including: a production capacity from 20% to 60% above the authorized amount; an emergency overflow pipeline not present in approved plant design; an emergency spill pond with a capacity 100% greater than that authorized; unauthorized use of well water to dilute waste

discharged into the river; the absence of regular secondary and tertiary treatments during the first three months of the plant's operations and the failure to report failures in the treatment systems; failure to monitor the massive discharges of particulate matter, sulfur dioxide (SO2), nitrogen oxide (NO2), TRS gases (hydrogen sulfide and mercaptans), and aerial emissions of carbon dioxide (CO2), and ozone (O3); and the surpassing of maximum permitted levels of multiple parameters, particularly water temperature, total phosphorous, biochemical oxygen demand (BOD) and chlorides, resinic acids, total nitrogen and total suspended solids, and electrical conductivity. MA&C Consultores (October, 2004) "Apoyo al Seguimiento Ambiental del proyecto Celulosa Planta Valdivia Celulosa Arauco y Constitución S.A." Final Report, Versión 3, N°2.

[18] Commonwealth of Australia, 1995. Environmental Guidelines for New Bleached Eucalypt Kraft Pulp Mills

[19] See http://www.ramsar.org/lib/lib_handbooks_s.htm. The following handbooks could be particularly useful to address the case of the Sanctuary: Handbook 1 – Wise use of wetlands; Handbook 8 – Managing wetlands; and Handbook 12 – Water allocation and management.

[20] Ley No 19.253, Title V Art. 34 states that the State's public agencies and territorial organizations when treating matters related to or affecting indigenous issues, should listen to and consider the opinion of the indigenous organizations recognized under this law. These organizations include both the indigenous communities, and, in the Lakes (10th) Region, the traditional *Cacicados* or councils of the Huilliche people.

[21] http://www.plantavaldivia.cl/pdf/Empleo2.pdf

[22] By August 2005, the first opinion poll (Encuesta CERC 2005) was published describing public opinion as to the course of the controversy and the behavior of the different sectors. This found a public highly critical of the company and of government regulatory action. Over 80% thought that CELCO had not complied with environmental regulations, and 43% thought that the company had not complied at all. This poor opinion extends to the timber sector as a whole, with 56% believing that these problems were common to other timber companies, and 54% had a negative opinión of CONAMA´s performance in the Sanctuary situation.

[23] El Mercurio, "Lagos acusa a CELCO de dañar la imagen del país", 7 de junio 2005.

[24] These pillars are derived from Principle 10 of the Rio Declaration on Environment and Development and are further elaborated in the Aarhus Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters (1998)

[25] Principle 15 of the Rio Declaration, agreed at the Earth Summit in June 1992 by Chile and 170+ other governments from around the World, provides that: "In order to protect the environment, the precautionary approach shall be widely applied by states according to their abilities. Where there are threats of serious or irreversible damage, lack of scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

[26] Statement by Kofi Annon on Aarhus Convention website, at www.unece.org/env/pp/

[27] See www.ramsar.org for additional information.

[28] Op Cit, World Bank. (1998); Australia, 1995. Environmental Guidelines for New Bleached Eucalypt Kraft Pulp Mills.

[29] Some of the most relevant information can be found in the following documents: CONAMA (2005) "Minuta de principales acontecimientos en el Seguimiento Ambiental del Proyecto "Valdivia" de Celulosa Arauco y Constitución S.A", February 2005; Claudio Zaror (2005) "Apoyo al análisis de fuentes de emisión de gran magnitud y su influencia sobre los ecosistemas de la subcuenca del Río Cruces". Partial Report. February 2005/Final Report. March 2005; and MA&C Consultores (2004) "Apoyo al Seguimiento Ambiental del proyecto Celulosa Planta Valdivia Celulosa Arauco y Constitución S.A." Final Report, Versión 3, N°2. October 2004.

[30] Rosemarin, A., K. Lehtinen, M. Notini and J. Mattson. 1994. Effects of Pulp Mill Chlorate on Baltic Sea Algae. Environ. Pollut. 85: 3-13.

[31] It should be considered as a standard procedure not to discharge "black liquor" directly into the recipient environment as it is highly toxic to aquatic life, as is lye as well as many other toxic compounds released from the cooking procedure. Weyerhaeuser, 2004 MSDS WC 074-08 Page 4 of 6.

[32] StoraEnso 2003, Gerd Wäne, Ola Svending, Eucalyptus Pulp Production - Environmental Impacts of Modern ECF and TCF bleaching – An LCA Study, Department: Chemical Pulp R&D,

[33] Jamieson, L. "Occupational Health and Safety in Pulp Mills Using Chlorine, Chlorine Dioxide, Hydrogen Peroxide and Ozone." Report Prepared for the Natural Resources Council of Maine, January (1997).

[34] Kennedy, S. et al. "Lung Health Consequences of Reported Accidental Chlorine Gas Exposures Among Pulp Mill Workers." American Review of Respiratory Disease 143, pp 74-79 (1991).

[35] Jay Ritchlin and Paul Johnston, 1999. Zero Discharge: Technological Progress Towards Eliminating Kraft Pulp Mill Liquid Effluent, Minimising Remaining Waste Streams and Advancing Worker Safety.

[36] Hamilton, G. November 1994 "30 Degrees from Disaster: The Night MB Came Too Close for Comfort." Vancouver Sun

[37] Swedish Forest Industries, 2005-10-19**.** Press release. http://www.skogsindustrierna.org

[38] Stockholm University 2005, Mats Olsson, Dioxiner i kustlevande fisk från södra Bottenhavet, en studie av presumtiva föroreningskällor.

[39] Op Cit, World Bank.
[40] Nordic paper Magazine, 6, 2005
[41] Op cit, UACh 2005.
[42] European Commission July 2000. Integrated Pollution Prevention and Control (IPPC): Reference Document on Best Available Techniques in the Pulp and Paper Industry.
[43] Marko Salo, 1999. Environmental best practices in the forest cluster. International Institute for Applied Systems Analysis, Austria.
[44] Precautionary Principle, Wingspread Statement, January 28, 1998, Racine, Wisconsin
[45] For dioxin impacts, see WWF-US website: www.worldwildlife.org/toxics/pubs.cfm "Dioxins Questions & Answers (December 2004)
[46] Agenda 21, Chapter 8.31
[47] COREMA, Resolución de Calificación Ambiental 377 de 6-6-05.
[48] Comisión de Medio Ambiente del Senado. Oficio MA/86/05. Valparaíso, 16 de junio de 2005. It should be noted that of the three major recommendations made by the senate commission, only one has been partially addressed by the government. See also, Declaration of the Chile´s Society of Botany, Agronomist Society and FORECOS Sciencitic Center, "Ante el grave deterioro del ecosistema del santuario de la naturaleza Carlos Anwandter de Valdivia." June 29, 2005. Valdivia.
[49] See Claudia Sepúlveda (1998) "La legitimidad del Sistema de Evaluación de Impacto Ambiental puesta en juego: el caso de la Planta de Celulosa Valdivia". Ambiente y Desarrollo Vol. XIV, Nº2. CIPMA, junio de 1998. Santiago y Francisco Sabatini, Claudia Sepúlveda y Hernán Blanco (1000) "Participación ciudadana para enfrentar conflictos ambientales: desafíos para el Sistema de Evaluación de Impacto Ambiental". CIPMA, Santiago. Octubre 2000.
[50] Ramsar Convention on Wetlands (1971), www.ramsar.org.
[51] For more details, see http://www.ramsar.org/key_montreux_record.htm
[52] See Draft Document, "Política Nacional de Áreas Protegidas", sección 1.2.2. i), Lentitud en la adecuación de normativas internas para implementar los compromisos adquiridos por Chile en los Tratados Internacionales en el ámbito de la protección del patrimonio natural – cultural, http://www.conama.cl/portal/1255/article-33613.html),
[53] Stockholm POPs Convention (2001), www.pops.int
[54] Id, Attachment C, Part II.
[55] Id, Attachment C, Part V(c).
[56] Id, Attachment C, Part V(f).
[57] OECD Environmental Performance Reviews – Chile. OECD, Economic Commission for Latin America and the Caribbean – UN ECLAC. Published by OECD Publishing, 2005. 230 pages.
[58] See Franz Xaver Perrez, The World Summit on Sustainable Development: Environment, Precaution and Trade – A Potential for Success and/or Failure, 12 RECIEL 15 (2003)
[59] Op cit, Stockholm POPs Convention, preamble.
[60] Id, Art. 5(c)
[61] Id, Art. 8.9
[62] WWF Issue Brief: "Persistent Organic Pollutants: Hand-Me-Down Poisons That Threaten Wildlife and People," (January 1999).
[63] Convention on Biological Diversity (1992), www.biodiv.org
[64] Id, see http://www.conama.cl/portal/1255/articles-31858_PlanAccionPais2004_2015.pdf
[65] Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 4 September 2002 (UN publication, Sales No. E. 03.II.A.1 and corrigendum), chap I, resolution 2, attachment.
[66] Id., Chapter IV, para. 42
[67] Id., Chapter III, para. 22

Attachment 1. Map of the River Cruces and Carlos Anwandter Nature Sanctuary and Ramsar site and CELCO Valdivia Pulp Plant.

Attachment 2. Population trend for the black-necked swan, red-gartered coot and spot-flanked gallinule in the River Cruces – Carlos Anwandter Nature Sanctuary and Ramsar site (from UACh 2005)

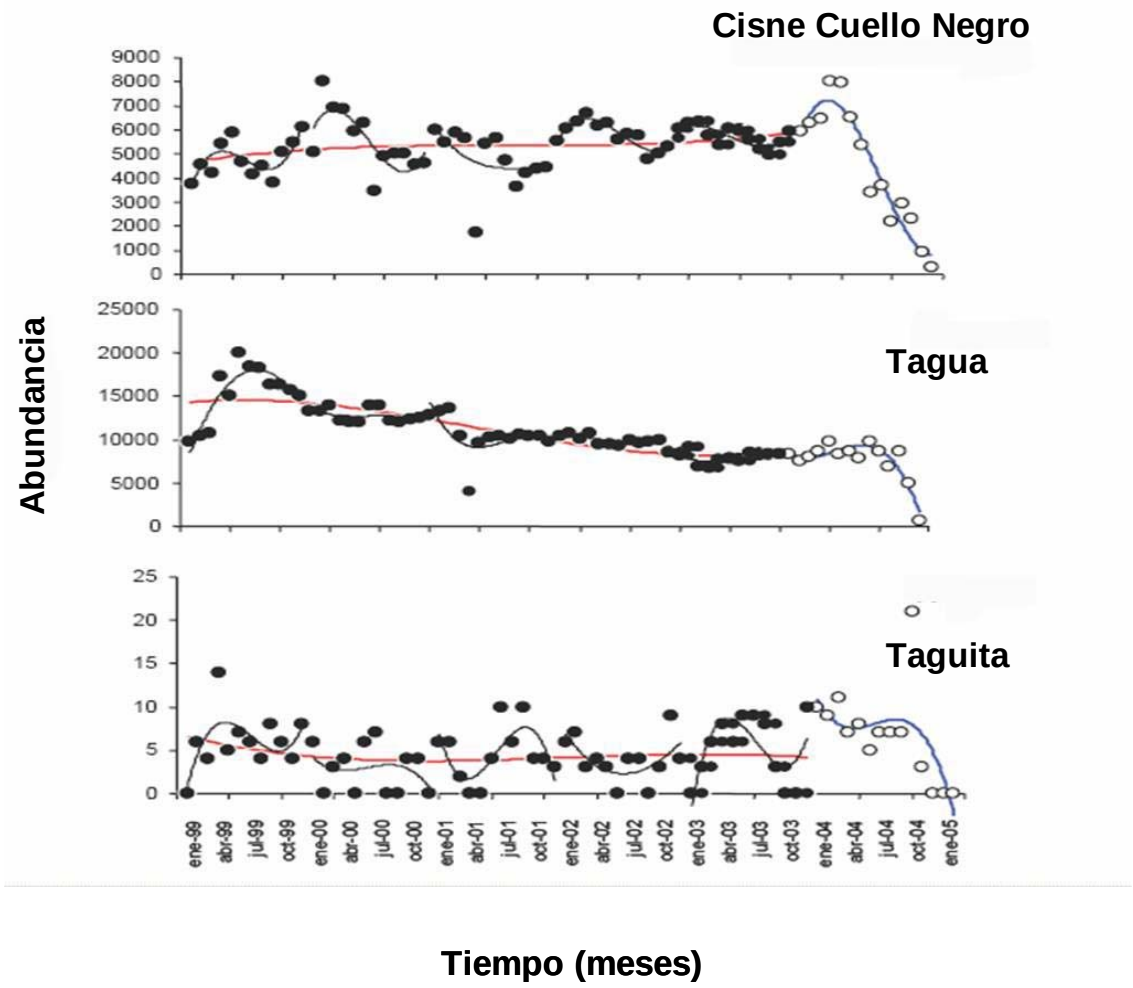
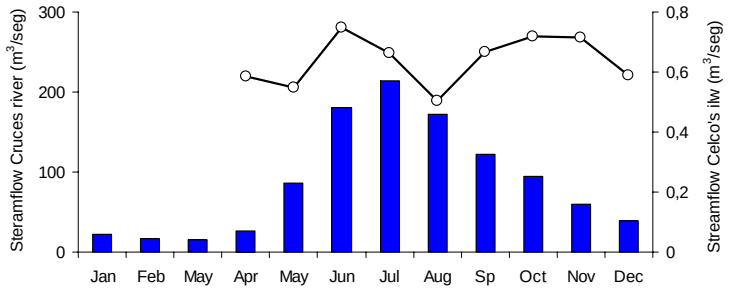
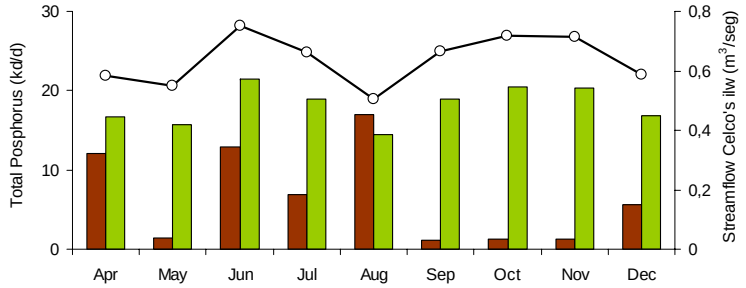
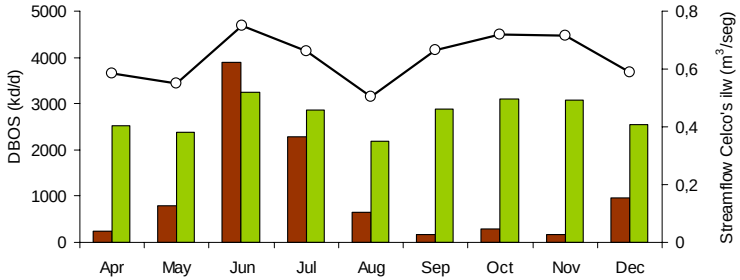


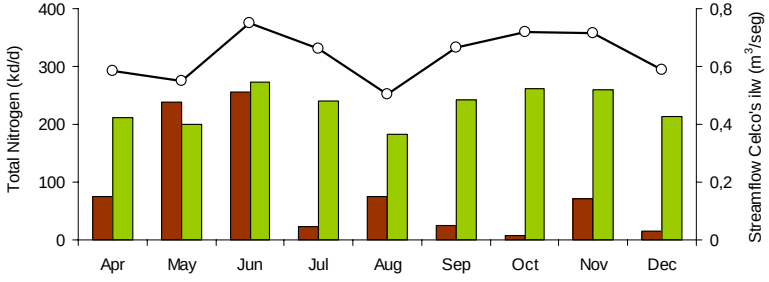
Figura 134. Abundancia poblacional del Cisne de cuello negro, la Tagua y la Taguita durante el periodo 1999-2005. En todos los casos, la línea roja (puntos negros) muestra la tendencia temporal dominante desde Enero de 1999 a Diciembre del 2003. La línea azul (puntos blancos) representa la tendencia temporal dominante desde Enero del 2004 a Febrero del 2005. Las líneas continuas en color negro representan la tendencia intra-anual para los años 1999, 2000, 2001, 2002 y 2003. La tendencia corresponde a un ajuste polinomial de 3er orden.

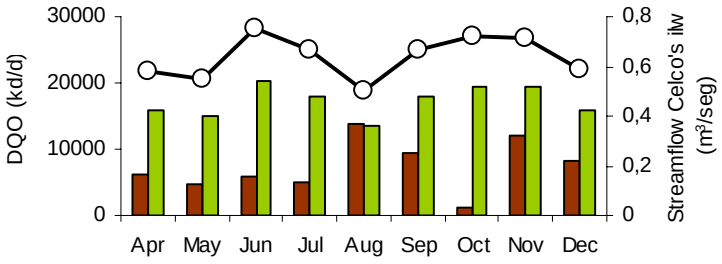
Attachment 3. Industrial Liquid Waste Monitoring Information for CELCO´s Valdivia Plant (2004) versus Cruces River stream flow.

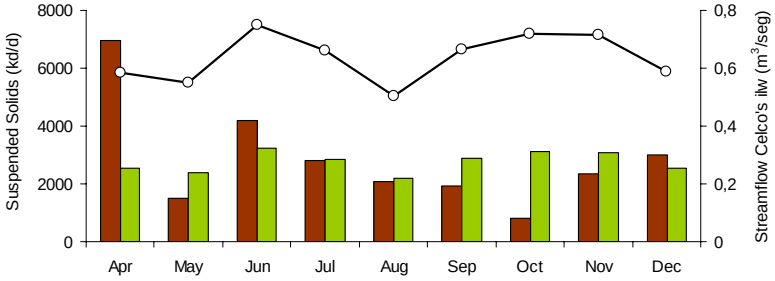












Attachments 4. Guidance for water monitoring (World Bank, 1998).

Parameter	*Sampling or monitoring system*
General	
PH	pH meter ISO (1980–91), Water Quality Standards APHA, ASTM, BS, DIN, SCA
BOD	Determine dissolved oxygen concentration in the test solution before and after incubation (APHA, ASTM, BS, DIN, ISO, SCA); 40 CFR, Part 136; USEPA Method 405.1
COD	Digest with potassium dichromate in strong acid solution with silver sulfate as catalyst after sample homogenization (APHA, ASTM, BS, DIN, ISO, SCA); 40 CFR, Part 136; USEPA Method 410.1
AOX	USEPA Method 1650 (titrimetric)
TSS	Filtration 40 CFR, Part 136; USEPA Method 160.2; APHA, BS, DIN, ISO, SCA
Total dissolved solids (TDS)	Pretreatment with membrane filtration, followed by evaporation APHA, BS, DIN, ISO, SCA
Phenol	Extract with MIBK, followed by GC analysis USEPA Methods 420.1, 420.2
Sulfide	React with dimethlphenylenediamine and ferric chloride in acid solution to form methylene blue; USEPA Methods 376.1, 376.2
Oil and grease	Extract with light petroleum, evaporate solvent, and measure weight USEPA Method 413.1
Organic compounds	
Total organic carbon	UV oxidation followed by infrared analysis USEPA Method 415.1; APHA, ASTM, DIN, ISO, SCA
Organics	40 CFR, Part 136.3 (GC, GC/MS, HPLC, ASTM D4657-87)
PAHs	Gas chromatography with flame ionization detection
Pesticides	Gas chromatography; 40 CFR, Part 136.3, Table 1-D.
Inorganic substances	
General reference	40 CFR, Part 136.3, Table 1-B.
Metals	
Arsenic	Atomic absorption spectroscopy; APHA, ASTM, SCA
Cadmium	Atomic absorption spectrometry; APHA, ASTM, BS, DIN, ISO, SCA Inductively coupled plasma emission spectrometry; ASTM, DIN, SCA
Chromium	Atomic absorption spectrometry; APHA, ASTM, BS, DIN, ISO, SCA Inductively coupled plasma emission spectrometry; ASTM, DIN, SCA
Lead	Atomic absorption spectrometry; APHA, ASTM, BS, DIN, ISO, SCA Inductively coupled plasma emission spectrometry; ASTM, DIN, SCA
Mercury	Flameless atomic absorption spectrometry; APHA, ASTM, BS, DIN, ISO, SCA
Nickel	Atomic absorption spectrometry; APHA, ASTM, DIN, SCA Inductively coupled plasma emission spectrometry; ASTM, DIN, SCA
Zinc	Atomic absorption spectrometry; APHA, ASTM, BSI, DIN, ISO, SCA

Note: See UNEP, Technical Report 27, for details. APHA, American Public Health Administration, *Standard Methods for the Examination of Water and Wastewater;* ASTM, American Society for Testing and Materials Standards, *Annual,* vols. 11.01, 11.02; BS, British Standards Institute, *Water Quality,* BS-6068; CFR, United States, *Code of Federal Regulations;* DIN, German Industrial Standard Methods for the Examination of Water, Wastewater and Sludge, DIN 38404–09; ISO, International Organization for Standardization, *Water Quality Standard Method;* SCA, Standing Committee of Analysts, U.K. Department of the Environment, *Methods for the Examination of Waters and Associated Materials.*

Attachments 5. Guidance for air monitoring (World Bank, 1998).

Parameter	*Sampling and analytical methods*
Stack gases	Extractive methods using pitot tubes; 40 CFR, Part 60, Appendix A, Methods 1–4; BS 1756:1977, Part 2
PM_{10}/ TSP	In situ nondispersive infrared spectrophotometry and extractive gravimetric; ISO 9096; ISO/TC 146/SCI/WG1N16(1994); 40 CFR, Part 60, Appendix A, Methods 5, 5A, 17; BS 3405:1983 VDI 2066, Parts 1, 2
Sulfur oxides	Extractive nondispersive infrared spectrophotometry; ISO 8178; 40 CFR, Part 60, Appendix A, Method 6; BS 1756:1977, Part 4; VDI 2462, Parts 1–7
Nitrogen oxides	Extractive fluorescence; ISO 8178; 40 CFR, Part 60, Appendix A, Method 7, 7A–7E; VDI 2456 Parts 1–7
VOCs	Extractive flame ionization; 40 CFR, Part 60, Appendix A, Method 18; VDI 3493, Part 1
Total hydrocarbons	Extractive nondispersive infrared spectrophotometry; 40 CFR, Part 60, Appendix A, Methods 25, 25A, 25 B; VDI 2460 (Parts 1–3), 2466 (Part 1), 3481 (Parts 1, 2), 2457 (Parts 1–7)
Carbon monoxide	Extractive nondispersive infrared spectrophotometry; 40 CFR, Part 60, Appendix A, Methods 10, 10A, 10B; VDI 2459, Part 6
Chlorine/hydrogen chloride	Extractive nondispersive infrared spectrophotometry; VDI 3488, Parts 1 and 2; VDI 3480, Part 1
Hydrogen sulfide	Extractive electrochemical analysis; VDI 3486, Parts 1–3

Note: Metals are usually analyzed by the methods outlined in Table 2. BS, British Standards Institute; CFR, United States, *Code of Federal Regulations*; ISO, International Organization for Standardization, *Method for the Gravimetric Determination of Concentration and Mass Flow Rate of Particulate Material in Gas-Carrying Ducts* (Geneva 1994); VDI, Germany, Federal Minister for the Environment, Nature Conservation and Nuclear Safety, *Air Pollution Control Manual for Continuous Emission Monitoring* (Bonn, 1992).