





# Part two

## our performance

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# Part two: Our performance

## Measuring our performance

CSIRO plays an important role in Australia's National Innovation System. Our combination of size, breadth and depth in capability, active research portfolio management and expertise in conducting large-scale, multidisciplinary, mission-directed research is unique. CSIRO is a leader in addressing major challenges that matter to Australia's future, including the complex interactions of human activity with the natural and built environments. This unique position enables CSIRO, to act as:

- ◆ a connector and collaborator across the innovation system to help Australia gain access to global knowledge
- ◆ a manager of research capabilities and facilities that are critical for national preparedness to understand national challenges and opportunities and support national priorities
- ◆ a Trusted Advisor to the nation.

Over 90 per cent of our resources are directed to the Government's National Research Priorities and our activities are strongly aligned with the National Innovation Priorities. To achieve this, the CSIRO Strategy 2011–15 is underpinned by five strategic objectives:

1. National Flagships
2. Science Excellence and Preparedness
3. Deep Collaboration and Connection
4. Innovation Organisation
5. Trusted Advisor

The Organisation intends to plan progressively, implement change initiatives and embed these processes and practices as 'business as usual' to ensure we deliver on our five strategic objectives over the life of the strategy. The 2011–12 Operational Plan and Portfolio Budget Statements provide an overview of the priorities, planned programs, change initiatives and other key activities, along with the resources to implement these for the first year of the new strategy.

CSIRO's activities and achievements are outlined in this section of the annual report and provide evidence of our performance against the Operational Plan and the Portfolio Budget Statements. In addition to this annual report to Parliament, CSIRO also monitors its performance throughout the year by providing:

- ◆ regular reports to the CSIRO Executive Team and Board to assist them with their decision-making and governance responsibilities
- ◆ detailed planning and review processes operating at a range of levels, including research portfolios and Divisions, functional areas and individuals.

## Financial performance

In 2011–12, CSIRO delivered a surplus from ongoing operations of \$13.8 million. However, our overall position was a surplus of \$200.5 million due to the recognition of \$228.6 million attributable to WLAN licensing agreements offset by other adjustments including the write-down and impairment of assets. Total revenue of \$1,476.0 million included appropriation from government of \$724.9 million and \$751.0 million in revenue generated from other sources (representing a 50.1 per cent increase over prior year). Compared with 2010–11, the net value of CSIRO's non-financial assets increased by \$52 million, which was largely due to an increase in assets under construction.

CSIRO's parent financial performance in 2011–12 is summarised in Table 2.1, page 3, (by source of revenue) and CSIRO's consolidated financial performance by PBS Program is summarised in Table 2.2, page 3.

**TABLE 2.1: CSIRO FINANCIAL PERFORMANCE 2011–12, \$M<sup>1</sup>**

FINANCIAL PERFORMANCE					
REVENUE SOURCE	2007–08	2008–09	2009–10	2010–11	2011–12
Co-investment, consulting and services					
Australian private sector	68.2	62.1	61.0	65.0	74.2
Australian Governments	119.5	161.4	189.3	202.7	201.8
Rural Industry R&D corporations	30.2	33.8	33.5	37.7	35.0
Cooperative Research Centres	38.2	43.6	38.8	32.3	30.0
Overseas entities and international	35.3	61.5	71.6	74.5	77.5
Work in progress / deferred revenue	-1.4	-14.5	-13.6	5.9	-7.6
<b>Total co-investment, consulting and services</b>	<b>290.0</b>	<b>347.9</b>	<b>380.4</b>	<b>418.1</b>	<b>410.9</b>
IP – royalty and licence revenues	81.7	229.6	46.7	29.2	278.5
<b>Total research and services revenue</b>	<b>371.7</b>	<b>577.5</b>	<b>427.1</b>	<b>447.3</b>	<b>689.4</b>
Other external revenue	41.3	31.3	28.2	47.9	61.3
Gain / (loss) on sale of assets	4.8	25.6	3.9	4.9	0.4
Other fair value gains and reversals	10.8	0.3	-	0.1	-
<b>Total external revenue</b>	<b>428.6</b>	<b>634.7</b>	<b>459.2</b>	<b>500.2</b>	<b>751.0</b>
Revenue from Government	663.2	668.1	704.9	720.4	724.9
<b>Total revenue</b>	<b>1,091.8</b>	<b>1,302.7</b>	<b>1,164.1</b>	<b>1,220.6</b>	<b>1,476.0</b>
Less expenses	1,044.1	1,180.8	1,333.1	1,231.1	1,275.5
Operating result	47.7	122.0	-169.0	-10.5	200.5

**TABLE 2.2: CSIRO – FINANCIAL SUMMARY BY PBS PROGRAM<sup>2</sup>, 2011–12, \$M**

	ACTUAL	PBS 2011–12 BUDGET	VARIANCE
Government revenue	724.9	724.9	0.0
External revenue	741.7	552.5	-189.2
Other revenue	5.5	0.0	-5.5
<b>Total revenue</b>	<b>1,472.1</b>	<b>1,277.4</b>	<b>-194.7</b>
Program 1 – National Research Flagships	554.9	566.2	11.3
Program 2 – Core Research and Services	575.5	562.4	-13.1
Program 3 – Science Outreach: Education and Scientific Publishing	32.1	36.6	4.5
Program 4 – National Research Infrastructure: Facilities and Collections	100.4	114.8	14.4
Program 5 – Science and Industry Endowment Fund	15.6	18.7	3.1
<b>Total expenses</b>	<b>1,278.6</b>	<b>1,298.7</b>	<b>20.1</b>

1 Previous year historical segment balances (07–08 to 10–11) may have changed due to updated classification methodology.

2 Portfolio Budget Statement Programs. For information on these programs, see page 16.

## Strategy progress – Enterprise Strategy Measures

Multiple lines of evidence are used to monitor overall achievement against our strategy, including reporting against ten Enterprise Strategy Measures (ESMs). The ten ESMs are designed to provide evidence of our performance across four dimensions that are critical to the success of the CSIRO Strategy 2011–15. These dimensions are:

- ◆ *Impact*: Delivering results with relevance and impact across areas of importance for Australia
- ◆ *Science*: Performing high-quality science
- ◆ *People*: Building and maintaining strong relationships with customers, partners, staff and other stakeholders
- ◆ *Resources*: Effective resourcing of CSIRO’s activities.

Table 2.3 provides a summary of actions taken and progress achieved against our ESMs.

**TABLE 2.3: ENTERPRISE STRATEGY MEASURES**

IMPACT	
●●●○○ <sup>1</sup>	<p><b>1. Develop measures in 2011–12 for benchmarking our performance for delivery of triple-bottom-line<sup>2</sup> impact through evaluating realised benefits. Be recognised as one of the top three global applied science organisations by 2014–15 for impact delivery as measured against our 20 global peers.</b></p> <p>In 2011–12, CSIRO commenced the process of developing a balanced scorecard to measure the Organisation’s performance in terms of financial, people, outputs and adoption of research to benchmark against its global peers. The aim is to demonstrate that, by 2014–15, CSIRO is recognised as one of the top three applied science organisations globally. The next steps to achieve this will be to work with peers to coordinate the data collection process during 2012–13, with a view to reporting the first set of results in 2013–14.</p>
●●●●●	<p><b>2. Develop future impact pipelines for at least 80 per cent of the Flagships Portfolio by June 2012; evaluate potential triple-bottom-line value for at least 50 per cent of the Flagship future pipeline by June 2013 and 80 per cent by June 2014. Deliver Flagships’ goals at a rate meeting or exceeding initial time-to-goal expectations</b></p> <p>As at 30 June 2012, 89 per cent of the National Research Flagships Portfolio (eight of the nine Flagships) successfully completed development of their future intended impact statements. This included defining the triple-bottom-line outcome statements and time-to-goal estimates for the various themes of science research that deliver the eight Flagships. This work has laid the foundation for evaluating the estimated time-to-goal delivery for the Flagship’s outcomes and provides a base against which CSIRO can ensure initial time-to-goal expectations are being met or exceeded.</p> <p>For more information see the Operational Plan Key Executive Actions on page 8.</p>
●●○○○	<p><b>3. Baseline customers’ ‘willingness to recommend’ in 2011–12 and improve our performance year-on-year over the strategy.</b></p> <p>This year, CSIRO completed a trial to test the validity of a proposed customer satisfaction survey. Results of this trial are being incorporated into a final survey, which is expected to be implemented in 2012–13 and performance benchmarked in 2013–14.</p>

1 The coloured circles represent a rating of the overall progress towards the 2012–2015 CSIRO Strategy Plan Enterprise Strategy Measure on a scale from one to five.

2 The triple-bottom-line refers to economic, social and environmental impacts.

●●○○○<sup>3</sup> **4. Increase the community awareness of impact derived from CSIRO activities from the established baseline in 2010–11 to 75 per cent by 2014–15.**

In 2011, 40 per cent of Australians questioned in an on-line survey were able to name at least one contribution they believed CSIRO had made to their life. In an effort to increase this result to 75 per cent by 2014–15, CSIRO developed a five-year community engagement strategy designed to increase community awareness of the impact of CSIRO's research.

For more information see Program 3 – Science Outreach: Education and Scientific Publishing on page 59.

SCIENCE

●●●●○ **5. Science quality is maintained or improved in Environment and Ecology, Agricultural Sciences, Plant and Animal Sciences, and Geosciences as measured through benchmarking against global peers (science productivity, citations per paper, collaboration). CSIRO maintains breadth in at least 14 fields in the top one per cent globally based on ISI/Thomson Reuters total citation data.**

In 2011–12, CSIRO remained in the top 0.1 per cent of global institutions in four major research fields – Environment and Ecology, Agricultural Sciences, Plant and Animal Sciences, and Geosciences. These four fields account for 60 per cent of CSIRO's total output in terms of citations and publication numbers. In addition, CSIRO ranks in the top 1 per cent of global science institutions across a further ten fields. In total, across 22 globally recognised research fields, CSIRO has maintained its position of being in the top 1 per cent of global institutions in 14 of these fields.

For more information see Program 2 – Core Research and Services on pages 40–45.

●●●○○ **6. Progress towards establishing precincts of global standing in the Plant and Agricultural Sciences, Resource Sciences, Environmental Sciences, Materials and Manufacturing Sciences and Human Life Sciences meets Precinct Development Plans by 2014–15.**

The CSIRO Board approved the establishment of five global precincts (see Figure 2.1) to consolidate resources and optimise opportunities to build on and integrate, research and development.

For more information see the Operational Plan Key Executive Actions on page 9.

FIGURE 2.1: GLOBAL PRECINCTS BY RESEARCH FOCUS AND LOCATION



**RESOURCE SCIENCES: PERTH**

Leading minerals and energy research development centre.

**ECOSCIENCES: BRISBANE**

World's largest environmental sciences hub solving the nation's critical environmental challenges and opportunities.

**NATURAL & ENVIRONMENTAL SCIENCES: CANBERRA**

Focused on natural and environmental sciences. Integrate academia, applied research, government and industry.

**HUMAN LIFE SCIENCES: PARKVILLE**

Integrate world-class healthcare, research and education to rapidly translate discoveries into clinical practice.

**MANUFACTURING & MATERIALS SCIENCES: CLAYTON**

Enabling capability in advanced materials and clean manufacturing technologies.

3 The coloured circles represent a rating of the overall progress towards the 2012–2015 CSIRO Strategy Plan Enterprise Strategy Measure on a scale from one to five.

●●○○○<sup>4</sup> **7. No fatalities or major injuries of CSIRO people. Lost time injury frequency rate (LTIFR)<sup>5</sup> and medical treatment injury frequency rate (MTIFR)<sup>6</sup> improves year-on-year and is in the top quartile of like organisations by 2014–15.**

In 2010–11, CSIRO introduced a new method of reporting major injuries for LTIFR and MTIFR. Using this new approach for the first full year, the reported LTIs were 53 and the MTIs were 80. CSIRO's Energy Technology Division achieved the best performance in terms of our Zero Harm objective with no LTIs or MTIs reported.

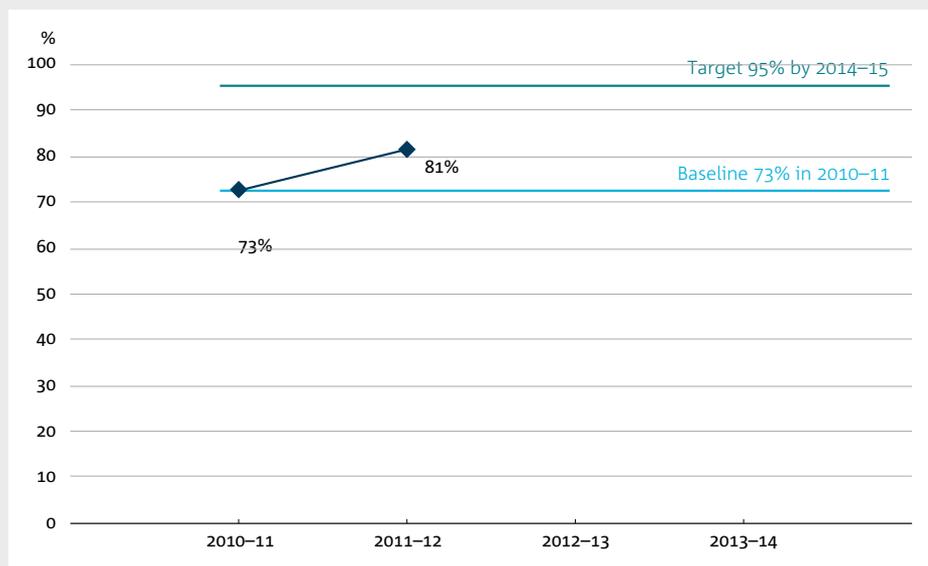
Muscular skeletal type injuries present the greatest risk across CSIRO, with 53 per cent of LTIs and 63 per cent of MTIs resulting from body stressing. An enterprise team is currently developing an intervention plan with activities to reduce body stressing type injuries.

For more information on CSIRO's Health, Safety and Environment see pages 84–86.

●●●●○ **8. Awareness of CSIRO's Values increases from the established baseline of 73 per cent (2010–11) to 95 per cent in 2011–12. A baseline for the use of Values in guiding behaviours and decision-making is established by June 2012 and improves year-on-year over the strategy period.**

Results from an all Staff Survey indicated an eight per cent increase in staff's awareness of CSIRO's Values between 2010–11 and 2011–12 (see Figure 2.2). This positive result is evident by the improved overall awareness and application of CSIRO's Values. Results indicated that staff are actively applying CSIRO's Values.

**FIGURE 2.2: AWARENESS OF CSIRO VALUES**



CSIRO continues to review responses to survey questions to improve the application of our values in the Organisation. Progress against this metric will be assessed through subsequent surveys.

- 4 The coloured circles represent a rating of the overall progress towards the 2012–2015 CSIRO Strategy Plan Enterprise Strategy Measure on a scale from one to five.
- 5 LTIFR is the number of incidents involving lost time from work greater than or equal to one full day or shift per million hours worked.
- 6 MTIFR is the number of incidents requiring medical treatment (beyond first aid) per million hours worked.

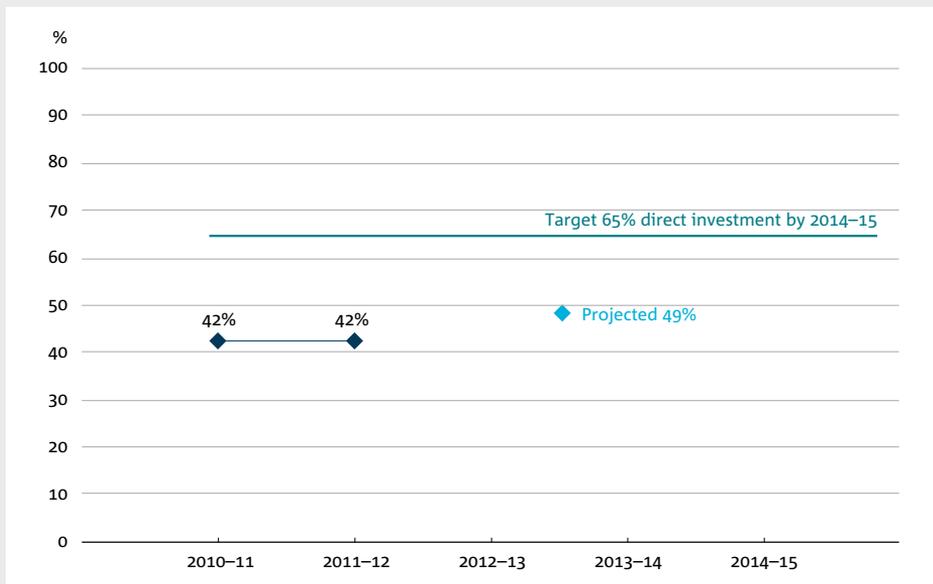
●●●●○ 9. CSIRO’s financial, operating and capital management performance meets approved annual budget.

CSIRO’s financial, operating and capital management performance was within the approved annual budget. The final result for the year is an overall surplus. This result can be attributed to the wireless local area network (WLAN) licence settlement late in the financial year. CSIRO will not fully spend its capital budget due principally to an underspend on major projects.

●●●○○ 10. Direct investment of CSIRO resources towards major national challenges and opportunities through the National Research Flagships increases to 65 per cent by 2014–15.

In 2011–12, direct investment in the National Research Flagships Program remained consistent with previous years at 42 per cent (see Figure 2.3). This is expected to increase to 49 per cent in 2012–13 due to the establishment of the Biosecurity and Digital Productivity and Services Flagships on 1 July 2012.

**FIGURE 2.3: DIRECT INVESTMENT OF CSIRO RESOURCES IN NATIONAL RESEARCH FLAGSHIPS**



For more information see the Operational Plan Key Executive Actions on page 8.

7 The coloured circles represent a rating of the overall progress towards the 2012–2015 CSIRO Strategy Plan Enterprise Strategy Measure on a scale from one to five.

## Operational Plan implementation

The 2011–12 Operational Plan identified 20 Key Executive Actions (KEAs) to progress the CSIRO Strategy. These actions are designed to focus the Board and the Executive Team’s attention on the most important priorities of the Organisation<sup>3</sup>. Table 2.4 provides a summary of actions taken and progress achieved.

**TABLE 2.4: STRATEGY IMPLEMENTATION 2011–12**

STRATEGIC OBJECTIVE AND KEY EXECUTIVE ACTION	ASSESSMENT OF PROGRESS <sup>1</sup>	SUMMARY OF PROGRESS
<b>Strategic objective 1 – National Research Flagships</b>		
<b>Focus and increase the Organisation’s resources invested in delivering profound impact in response to national challenges and opportunities through the National Research Flagships Program.</b>		
Develop investment cases for new Flagships in Biosecurity and Digital Productivity and Services, secure stakeholder support with a view to commencing, as appropriate, the Flagships in 2012–13.	●●●●●	<p>In June 2011, the CSIRO Board approved the establishment of two new National Research Flagships, which began operations on 1 July 2012. The Biosecurity Flagship will support Australia’s social, environmental and economic wellbeing by reducing the incidence of pest and disease incursions and increase the effectiveness of incursion mitigation and eradication responses by 2042. The Digital Productivity and Services Flagship will create \$4 billion in added value per annum to the Australian economy by developing and delivering more efficient and innovative services that improve citizen wellbeing and prosperity by 2025.</p> <p>For more information on the existing National Research Flagships see Program 1 – National Research Flagships on pages 16–39.</p>
Implement first key initiatives from a finalised strategic plan for the ‘Integrated Carbon Pathways’ project.	●●●○	<p>The Integrated Carbon Pathways (ICP) project completed a strategic review including soliciting feedback on proposed activities from key stakeholders in government and industry as part of the strategic plan development process. The review concluded that CSIRO should prepare a regular National Outlook report every 2–3 years, to provide a science based assessment and forecast for Australian sustainability, resource use and natural capital. The project is also developing ICP capacity to deliver analysis and projects across interconnected energy, food, water, landscapes and urban systems.</p>
Map our intended future Flagship impact and establish routine evaluation processes, using common methodologies across the Flagship’s portfolio.	●●●○	<p>On 30 June 2012, an 18-month pilot initiative to plan, monitor and evaluate the future intended impact of the Flagship’s Portfolio was completed. The initiative developed a methodology which was independently reviewed and validated by the Centre for International Economics (CIE).</p> <p>A review of the pilot initiative is due to be finalised in September 2012. Following this review, CSIRO will commence embedding the methodology into its enterprise planning and review processes to enable the development of measures and evaluation.</p> <p>For more information see Enterprise Strategy Measure two on page 4.</p>

<sup>1</sup> The coloured circles represent a rating of the overall progress compared to the 2011–12 Operational Plan Key Executive Action on a scale from one to five.

<sup>3</sup> CSIRO Operational Plan 2011–12, see page 10–11 at: [www.csiro.au/operational-plan](http://www.csiro.au/operational-plan)

**Strategic objective 2 — Science excellence and preparedness****Invest in people and infrastructure to maintain and develop national scientific breadth and depth in support of delivering profound impact and scientific preparedness.**

<p>Develop an integrated program to drive our global science standing, which includes attracting, developing and retaining world-class people.</p>	<p>●●●○</p>	<p>Our focus this year has been on refining the science capability strategy to ensure investment in our people and infrastructure is strategically aligned to deliver profound impact and scientific preparedness into the future. The key factors identified through this alignment process have been included in a draft roadmap for CSIRO to maintain its competitive advantage and influence nationally and globally. The roadmap is expected to be finalised in 2012–13.</p> <p>For more information see Program 2 — Core Research and Services on pages 40–55.</p>
<p>Refresh the long-term capital investment strategy and obtain approval by the CSIRO Board.</p>	<p>●●●○</p>	<p>A refreshed long-term capital investment strategy was developed. The strategy will provide a solid foundation for strategic investment in infrastructure in line with the breadth and depth of CSIRO's scientific excellence and preparedness. The strategy will be presented to the CSIRO Board next year.</p>
<p>Establish a shared science and impact vision for Global Precincts (including science focus; partners; funding options) and establish internal governance arrangements to support CSIRO investments.</p>	<p>●●●○</p>	<p>CSIRO continues to work towards the establishment of global precincts in Brisbane, Canberra, Melbourne (Clayton and Parkville) and Perth. The precincts will support Australia's innovation potential, improve Australia's research and development competitiveness, and position our National Innovation System to better address national and global challenges. To support this process, CSIRO established a Precinct Oversight Committee to oversee the precinct program, including development of precinct plans and appointment of leaders to each of the five sites. In addition, two sites (Brisbane and Perth) have also established site specific governance arrangements to coordinate engagement between key stakeholders.</p> <p>For more information see Enterprise Strategy Measure six on page 5.</p>
<p>Evaluate options for a coordinated national approach to national biological collections and seek support for integration of our major biological collections within a wider vision of a Canberra Precinct.</p>	<p>●●●○</p>	<p>In 2011–12, eight major biological collections were consolidated into a new virtual Australian National Biological Collections Facility. This new virtual facility became operational on 1 July 2012. In addition, the five largest collections were evaluated within the context of the national landscape to determine their research significance which was high. In 2012–13, CSIRO will establish a national approach to biological collections and include their scope and vision for the Canberra precinct.</p> <p>For more information see Program 4 — National Research Infrastructure: National Facilities and Collections on pages 61–68.</p>
<p>Develop and commence implementation of enterprise-level research data management processes and systems aligned with CSIRO's e-Research and e-Enablement strategy.</p>	<p>●●●○</p>	<p>Significant progress has been made on the development and implementation of the enterprise-level research data management processes and systems. As at 30 June 2012, 500 records were deposited in a new Research Data Service that covers a wide range of CSIRO research domains, 300 of which are available externally. This leading-edge system development involving comprehensive workflow support, provides the enterprise-level capability to describe, store, curate, reuse and enable access to research data assets created by CSIRO research groups.</p>

1 The coloured circles represent a rating of the overall progress compared to the 2011–12 Operational Plan Key Executive Action on a scale from one to five.

**Strategic objective 3 — Deep collaboration and connection****Build deep connections with and among the best partners in Australia and the world to complement our science capability and accelerate impact delivery.**

Grow national and international alliances with major industry, government and community partners in 2011–12 especially in domains critical to the delivery of Flagship's goals.	●●●●○	<p>Strategies have been developed and implemented to build alliances and expand our strategic partnerships with key stakeholders especially in domains critical to the delivery of Flagship's goals. Some examples of strengthened strategic research alliances this year include:</p> <ul style="list-style-type: none"> <li>◆ forming a five-year \$25 million strategic research program with Boeing, which builds on a 23-year relationship and increases existing connections by 30 per cent with a number of major clients conducting more than \$1 million research</li> <li>◆ securing \$2.9 million additional funding from AusAID to undertake a two-year 'Pathways to Food Security' in West Africa's research program</li> <li>◆ securing \$9.15 million from the Australian Government's Filling the Research Gap funding program, which is part of the Carbon Farming Futures Program. The funds will be used to research abatement technologies, strategies and innovative management practices to reduce greenhouse gas emissions, sequester carbon and enhance sustainable agricultural practices.</li> </ul> <p>For more information see Collaborations, connections and advice on pages 13–15.</p>
Execute strategies to improve relations and expand collaborations with five key international and ten key national research partners.	●●●●○	<p>CSIRO expanded and improved relations with the European Union, United Nations (through the Spatial Data Infrastructure project in Indonesia), Orica, AusAid, the National Oceanic and Atmospheric Administration and the Chinese Academy of Science, through collaborations on various internationally focused initiatives. In addition, CSIRO continued to explore major research initiatives through the Global Research Alliance. CSIRO also hosted joint high-level activities with Embrapa (Brazil), the Japanese National Institute of Advanced Industrial Science and Technology, and opened the CSIRO-Chile Centre of Excellence in Mining and Mineral Processing in December 2011.</p> <p>On a national scale, collaborations have also strengthened with State Governments, the Department of Agriculture, Fisheries and Forestry, and the Australian Solar Institute. CSIRO also executed a Strategic Relationship Agreement with the University of Melbourne, and is expected to finalise similar agreements with other universities in 2012–13.</p> <p>For more information see Collaborations, connections and advice on pages 13–15 or Publication collaboration in Program 2 — Core Research and Services on pages 40–45.</p>

1 The coloured circles represent a rating of the overall progress compared to the 2011–12 Operational Plan Key Executive Action on a scale from one to five.

STRATEGIC OBJECTIVE AND KEY EXECUTIVE ACTION	ASSESSMENT OF PROGRESS <sup>1</sup>	SUMMARY OF PROGRESS
Support Australia's bid for the Square Kilometre Array (SKA) and evaluate (and execute as appropriate) options for CSIRO's level of involvement, noting the SKA site decision is due early 2012.	●●●●○	<p>In May 2012, following a comprehensive tendering process for the SKA project, it was announced by the SKA Organisation that Australia would be one of three host countries (Australia, New Zealand and South Africa) for the first phase of the SKA Survey telescope (2016–20).</p> <p>The decision by the SKA Organisation is viewed positively by the Government, with broad recognition of CSIRO's leadership role in the project.</p> <p>For more information see Program 2 – Core Research and Services on page 52.</p>
Review and refresh our partner alliances and science directions for regional sites.	●●●●○	<p>A Regional Sites Working Group was established to anticipate the science directions of our regional sites. Following consultation with staff, the Working Group presented a report to CSIRO's Consultative Council and the Executive. The report made ten recommendations, with implementation expected to commence in 2012–13 and be completed by 2015.</p>

#### Strategic objective 4 — Innovation organisation

##### Boost our capacity to operate as one organisation to respond to the changing nature of science, deliver profound impact and build capability for the future.

Further develop and apply an Innovation Maturity Model to understand the key drivers of innovation in a CSIRO context, baseline our existing maturity and identify key improvement opportunities.	●●●●○	<p>Significant progress has been made in increasing the Organisation's capacity to respond appropriately to the changing nature of science. The results of an all Staff Survey released in June 2012 were key in identifying opportunities to enhance CSIRO's capacity to innovate. The results also provided a baseline measure to assess future performance of CSIRO's innovation maturity.</p> <p>For more information see Our people on page 93.</p>
Review and realign (as appropriate) our Learning and Development curriculum and service offering, to ensure it prepares our people to deliver against CSIRO's distinctive role.	●●●●○	<p>In late 2011, CSIRO's learning and development priorities were realigned to support the delivery of the 2011–15 Strategy. To support this refreshed curriculum, a new Learning Management System (LMS) was developed to enable CSIRO to better understand and strategically align investment in learning and development. Feedback from key stakeholders about the LMS has been extremely positive.</p> <p>For more information see Our people on page 91.</p>
Further develop and implement strategic workforce capability plans for all our Divisions using a One-CSIRO approach.	●●●●○	<p>Strong progress has been made in a One-CSIRO approach to Workforce Planning, including the endorsement of a new Diversity and Inclusion Plan for 2012–15 by the Board Remuneration and Nomination Committee. This new plan, along with development of annual workforce plans for all Divisions, led to the most comprehensive view of Divisional capability the Organisation has had in recent history.</p>

1 The coloured circles represent a rating of the overall progress compared to the 2011–12 Operational Plan Key Executive Action on a scale from one to five.

STRATEGIC OBJECTIVE AND KEY EXECUTIVE ACTION	ASSESSMENT OF PROGRESS <sup>1</sup>	SUMMARY OF PROGRESS
Actively manage CSIRO's financial position to achieve a non-consolidated underlying operating and capital result consistent with the Board approved budget.	●●●○○	<p>CSIRO continued to actively manage its financial position to achieve a non-consolidated operating and capital result. The WLAN licence settlement has added to this position, resulting in an overall surplus outcome for the year. Further refinement of management processes for operating and capital budgets are planned for 2012–13 to ensure the Organisation maintains a sustainable financial position.</p> <p>CSIRO's financial performance for 2011–12 is summarised in Table 2.1 on page 3.</p>
Implement the Health, Safety and Environment (HSE) 2011–15 Strategy across the Organisation as we continue to build towards a 'Zero Harm' culture.	●●●○○	<p>Solid progress has been achieved against the 2011–15 HSE Strategy, particularly in the areas of awareness raising and the overall HSE maturity of the Organisation.</p> <p>For more information on CSIRO's HSE see pages 84–86.</p>

### Strategic objective 5 — Trusted Advisor

#### Play a leading role in the trusted delivery of scientific evidence, advice and interpretation to the Australian government, public and industry.

Develop and execute a systematic engagement strategy across CSIRO's impact domains including CSIRO position statements on national interest issues (for example, climate change) and emergency response issues (for example, biosecurity).	●●●○○	<p>During the year, the Prime Minister's Taskforce on Manufacturing and related review processes provided a catalyst for CSIRO to demonstrate to stakeholders the wide range of impact achieved across a number of science fields. The CSIRO Board approved an Industry Engagement Strategy, which developed a collection of facts and case studies for staff to use when engaging externally.</p> <p>For more information see Collaborations, connections and advice on pages 13–15.</p>
Revitalise CSIRO branding and marketing strategies (with associated co-branding options) and run three to five consumer orientated campaigns to increase awareness of CSIRO.	●●●●●	<p>A revitalised CSIRO brand was successfully launched with positive feedback from stakeholders. This new visual identity has been actively adopted internally and for external use by education, publishing, on-line and for traditional communication campaigns including, Food Security, State of the Climate, SKA and WLAN.</p>
Execute a strategy to use social media tools to communicate with selected key audiences.	●●●●○	<p>This year CSIRO successfully launched a range of social media initiatives. All media channels have grown in terms of authors and followers. A snapshot as at 30 June 2012 showed that our three newly launched blogs: news@csiro, solar@csiro and investigator@csiro reached approximately 38,000 followers a month. Social media tools are a key part of the strategy to reach target audiences and increase awareness of CSIRO's impact and role in delivering trusted scientific advice.</p> <p>For more information see Enterprise Strategy Measure four on page 5.</p>

1 The coloured circles represent a rating of the overall progress compared to the 2011–12 Operational Plan Key Executive Action on a scale from one to five.

## Collaboration, connections and advice

### UNIVERSITY COLLABORATION

CSIRO partners with 37 of the 39 public universities in Australia and with universities from more than 120 countries. These partnerships enable CSIRO to remain a key player in the training of future researchers, which will help build Australia's scientific capability and capacity.

CSIRO and partners are developing a number of innovation precincts, with the aim of increasing the proportion of CSIRO researchers co-located with our research partners. To support this, over 50 per cent of CSIRO staff are now located on, or adjacent to, an Australian university.

Some examples of collaborations during 2011–12 include:

- ♦ the successful completion of the South-East Queensland Climate Adaptation Research Initiative, the first comprehensive, regional study of climate change adaptation in Australia
- ♦ the signing of a strategic relationship agreement to encourage collaboration in human life sciences, water and materials with the University of Melbourne
- ♦ working with the University of Western Australia and Curtin University to understand the impact of extreme weather events on Western Australia's world heritage listed Shark Bay
- ♦ applying mathematics and computing to improve the management of mining supply chains with the University of Newcastle
- ♦ research with Swinburne University and other astronomers from Australia, Germany, Italy, America and the United Kingdom that identified a planet made of 'diamonds' (more on page 66)
- ♦ ongoing support for a number of joint PhD programs including the Quantitative Marine Science program with the University of Tasmania and the Integrated Natural Resource Management Science program with the University of Queensland.

### COOPERATIVE RESEARCH CENTRES

CSIRO remains the largest single participant in the Cooperative Research Centre (CRC) program. Throughout the life of the program, CSIRO has been a participant in 134 of the 190 CRCs that have existed, (rounds 1–13 inclusive). CSIRO's direct contribution to CRCs was \$27 million in 2011–12.

CSIRO will participate in five of the six successful Round 14 CRCs and will conduct research for a total cost of \$59 million over the lifetime of the CRCs, receiving \$34 million from the CRCs over the same period. This represents a total net investment by CSIRO of \$25 million. The new CRCs commenced operations on 1 July 2012.

CSIRO engages in CRCs to build critical mass in research ventures, which tackle clearly articulated major challenges for end-users and Australia.

### CUSTOMER ENGAGEMENT

CSIRO aims to be a Trusted Advisor to its partners – increasingly undertaking longer-term and more strategic research partnerships. Between 2008–09 and 2011–12, there was a 17 per cent increase in clients co-funding research worth \$1 million or more annually with CSIRO.

CSIRO added to its strategic research alliances in 2012 with the formation of a five-year, \$25 million strategic research program with Boeing, building on a 23-year relationship. CSIRO's long-standing partnership with Cotton Seed Distributors was further cemented with a five-year, \$35 million extension. CSIRO's existing alliances continued with clients including Orica Ltd, AusAID, Bayer and General Electric.

In 2011–12, CSIRO engaged with more than 2,500 clients, including more than 1,000 Australian small-to-medium enterprises. CSIRO's top five clients are Cotton Seed Distributors, NASA, AusAID, the Department of Sustainability, Environment, Water, Population and Communities and the Grains Research and Development Corporation.

CSIRO realigned its Business Development capability around five Group Business Development Leaders, resulting in integrated strategic planning and coordination of activities. CSIRO also conducted a review in 2012 of engagement with major corporate and Government clients and identified a series of initiatives to improve relationship management, to be implemented in 2012–13.

### FLAGSHIP COLLABORATION FUND

The Flagship Collaboration Fund supports CSIRO's National Research Flagships Program, which addresses issues of national significance. In 2011–12, the Fund provided \$17 million to external partners, including support for three new collaborative research clusters, spanning more than ten Australian and international universities. The clusters will address issues around minerals exploration, flexible electronics and measuring methane. There are currently 12 operational clusters of the 27 that have been funded by CSIRO.



**Dr Megan Clark (CSIRO Chief Executive) with the Chilean Minister for Mines, Mr Hernan de Solminihac (second from right) and Chilean representatives, at the opening of the new CSIRO-Chile International Centre of Excellence in Mining and Mineral Processing in Santiago, Chile. Image: Miguel Candia Ceballos**

During the year, the Fund advertised its seventh competitive cluster round that will result in new work around climate engineering for extreme events, a future energy network and improved understanding of ocean carbon. Over 20 new projects and several visiting fellowships were also funded to the value of \$1 million, as well as the highly successful student scholarships program. Over 30 new scholarships were supported which span well over 20 different national and international research partners.

#### **INTERNATIONAL ENGAGEMENT**

During 2011–12, CSIRO participated in more than 800 international activities in 76 countries, including scientific collaborations, commercial partnerships, capacity building, representational activities and the provision of advice on scientific matters to Government and other key stakeholders.

In December 2011, the CSIRO-Chile International Centre of Excellence in Mining and Mineral Processing was officially opened in Chile. The Centre will address major challenges facing both the Australian and Chilean mining industries.

CSIRO also signed a Memorandum of Understanding with the Brazilian Agricultural Research Corporation and with Japan's National Institute of Advanced Industrial Science and Technology, and have extended already strong relationships with key partners such as Boeing, AusAID and the Chinese Academy of Sciences.

Our participation in global knowledge networks also continues to grow through leading roles in programs such as the African Food Security Initiative and the Global Research Alliance (GRA), whose secretariat is now based at

CSIRO. The GRA is an international organisation promoting the application of science and technology to solve large-scale issues facing developing countries. CSIRO is a founding member, along with eight of the world's leading applied-research agencies.

#### **INDIGENOUS ENGAGEMENT STRATEGY**

During 2011–12, the Indigenous Engagement Strategy focused on recruiting Indigenous cadets and trainees. CSIRO entered into an agreement with an Indigenous employment organisation, Habitat Personnel, to develop an advertising and recruitment campaign. Ten positions were identified for traineeships and 25 for cadetships across Australia, with candidates filling traineeship positions in September 2012 and cadetships later in 2012.

Additionally, CSIRO recruited one Indigenous cadet in our Astronomy and Space Science Division, two in the Division of Ecosystem Sciences, one in Human Resources, and provided temporary employment for one candidate in Communications.

In 2011–12, Strategic Cultural Awareness programs were held in Brisbane, Canberra and Perth, engaging staff in scenarios aimed at experiencing contemporary Australian Indigenous societal issues.

The Indigenous Engagement Steering Committee met three times during the year. A review of the governance arrangements of the Indigenous Engagement Strategy was considered by the Committee in order to engage more effectively in seeking input from Aboriginal and Torres Strait Islander experts.

An officer of CSIRO's Office of Indigenous Engagement was appointed by the Minister to an Indigenous Expert Working Group on Indigenous Engagement with Sciences (EWGIES). The EWGIES project ensures the:

- ◆ development of a national strategy, aligned with Government and Inspiring Australia priorities, which will strengthen science engagement with Indigenous Australians
- ◆ facilitation of collaboration between stakeholders including government, business, academia, research, community groups and the broader community
- ◆ analysis of opportunities to improve and encourage science engagement with Indigenous Australians.

The Indigenous Expert Working Group's goal was to clearly outline recommendations for new and improved science engagement strategies for the science community.

#### **GOVERNMENT ENGAGEMENT**

A critical part of CSIRO's broader relationship with Government is its role as a Trusted Advisor, providing relevant scientific and technical input and advice to decision-makers. Key activities during 2011–12 included:

- ◆ Regular meetings with Ministers and parliamentarians and with senior staff from relevant government departments to provide scientific information and advice to inform policy development and program implementation and evaluation. Examples include ongoing engagement on issues of sustainability and carbon management, as well as the development of the National Plan for Environmental Information, the National Food Plan and the National Innovation System. CSIRO's Chief Executive has also been active in a number of Government forums including the Prime Minister's Science, Engineering and Innovation Council and the Prime Minister's Taskforce on Manufacturing.
- ◆ CSIRO made six submissions to Federal parliamentary inquiries and CSIRO officers attended ten hearings to provide further evidence to these inquiries.
- ◆ CSIRO held four Science for Breakfast briefings at Parliament House.

# Program performance

## CSIRO's outcome and program structure

CSIRO receives approximately 57 per cent of its operating revenue in appropriation funding through the Federal Budget. Our commitment to the parliament and people of Australia, set out in the 2011–12 Portfolio Budget Statements, is to contribute to the following outcome:<sup>4</sup>

**Innovative scientific and technological solutions to national challenges and opportunities to benefit industry, the environment and the community, through scientific research and capability development, services and advice.**

In pursuit of this outcome in 2011–12, CSIRO allocated funds across five Programs listed below and as outlined in Table 2.2, page 3:

- ◆ Program 1 – National Research Flagships
- ◆ Program 2 – Core Research and Services
- ◆ Program 3 – Science Outreach: Education and Scientific Publishing
- ◆ Program 4 – National Research Infrastructure: National Facilities and Collections
- ◆ Program 5 – Science and Industry Endowment Fund

These Programs reflect the Organisation's focus on delivering scientific solutions to Australian industry and communities, while simultaneously helping to build Australia's science base to meet ongoing challenges and opportunities.

The following sections provide a report against the deliverables and key performance indicators specified for each Program in the Portfolio Budget Statements.

## Program 1 – National Research Flagships

### Objectives and deliverables

Since the launch of the first three National Research Flagships in 2003, CSIRO has committed an increasing proportion of its resources to addressing major national challenges and opportunities through the National Research Flagships Program. In 2011–12, CSIRO devoted 42 per cent of its resources to nine Flagships: **Climate Adaptation; Energy Transformed; Food Futures; Future Manufacturing; Minerals Down Under; Preventative Health; Sustainable Agriculture; Water for a Healthy Country; and Wealth from Oceans.**

The Flagships address complex challenges by forming large-scale multidisciplinary research partnerships with Australian Universities and publicly funded research institutions, the private sector and selected international organisations. They target clearly defined goals, framed from a careful analysis of the needs of people and enterprises, and have a strong focus on adoption and impact.

### Program performance

The performance of the Flagship Program is assessed through five key performance indicators and a series of independent Flagship reviews. Table 2.5 provides a summary of progress. More detailed analysis and trend data follow the Table.

<sup>4</sup> The relevant section of the Portfolio Budget Statements can be viewed at [www.innovation.gov.au](http://www.innovation.gov.au). The Outcome is the formal legal statement of the purpose for which funds are appropriated to CSIRO.

**TABLE 2.5: PERFORMANCE INDICATORS FOR PROGRAM 1 – NATIONAL RESEARCH FLAGSHIPS**

KEY PERFORMANCE INDICATOR	TARGET	PERFORMANCE
Demonstrated adoption and impact of Flagship outputs.	Growing economic, social, environmental and intangible benefits	One external Flagship review was undertaken in the reporting year, with a final report to be submitted in late 2012. The process remains a robust and rigorous assessment of the adoption and impact of Flagship outputs by independent experts.  Recent achievements from each of the nine Flagships are reported on pages 22–39.
The number of refereed Flagship publications.	Maintain or increase	In 2011, CSIRO maintained its output in refereed Flagship publications, with 913 journal articles <sup>1</sup> , 461 conference papers <sup>2</sup> , 86 books or book chapters and 158 technical reports (more on pages 18–19).
Financial support by Flagship partners.	Maintain or increase	The total revenue from external partners increased to \$212 million (from 20 per cent to 40 per cent) of the Program’s total investment (more on page 19).
Customer satisfaction.	Maintain	A customer satisfaction survey trial was conducted in 2011–12. A baseline against which we will track performance will be established in 2012–13 (more on page 20).
Investment of the Flagship Collaboration Fund.	As per plan	As at 30 June, over \$121 million has been committed for the life of the Fund, including contractual arrangements to 2014–15. This exceeds the original government allocation of \$114.25 million (more on page 20).

1 Source: CSIRO’s electronic publications repository ‘ePublish’.

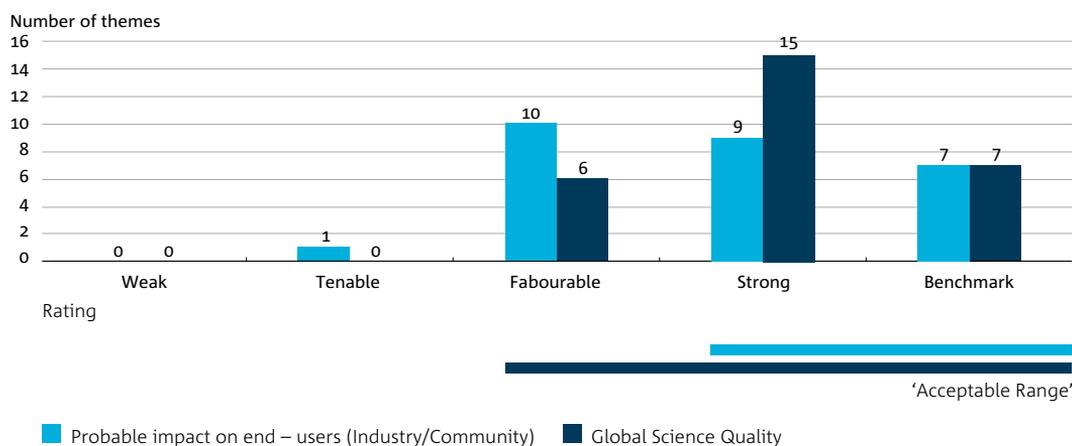
2 For technical reasons, these figures may underestimate the number of CSIRO papers that were produced in part or in whole from Flagships.

### Economic, social, environmental and intangible benefits (including Flagship peer reviews)

To maximise achievement of Flagship goals, CSIRO conducts a three-to-four year cycle of independent reviews of each Flagship. Each review is conducted by a panel of experts

from Australia and overseas. The results from the reviews completed to date can be seen in Figure 2.4. Table 2.6 shows the independent review panel’s ratings (according to a five point scale) for probable impact on end-users and quality of science.

**FIGURE 2.4: RESULTS OF FLAGSHIP SCIENCE REVIEWS**



**TABLE 2.6: RATINGS FOR TWO DIMENSIONS PROVIDED BY INDEPENDENT REVIEW PANELS<sup>5</sup>**

	PROBABLE IMPACT ON END-USERS (COMMUNITY / INDUSTRY)	QUALITY OF THE SCIENCE
Benchmark	The research results are used to set the pace and direction of commercial, environmental, community or policy development – recognised in industry or the community for this. The Flagship is on track to achieve and exceed the goals necessary for the declared outcome.	Sustained scientific leader – well recognised in the international research community.
Strong	The research results enable commercial, environmental, community or policy development that distinguishes user organisations from peers or competitors. The Flagship is on track to meet its timelines and milestones toward output goals.	Able to set and sustain new scientific/technical directions within the international research community.
Favourable	The research results enable commercial, environmental, community or policy development that organisations use to improve their position relative to peer or competitors. The Flagship will contribute outputs to the path to cited goals.	Able to maintain a good position within the international research community; not a scientific leader except in niches outside mainstream areas.
Tenable	The research results are used by organisations for commercial, environmental, community or policy development that maintains, but does not improve, their position relative to peers or competitors. The Flagship will make contributions towards meeting its milestone and output timelines.	Not able to set or sustain independent scientific/technical directions – a sense of being continually a follower.
Weak	The research results are not able to be used by organisations to even maintain their position relative to peers or competitors. The Flagship will not significantly advance Australia towards meeting the national challenge.	Declining quality of scientific/technical output compared with other research groups. Often a short-term reactionary focus.

As at 30 June 2012, seven Flagships had been reviewed since 2002 by a panel through the Flagship Science Review process<sup>6</sup>. In 2011–12, an eighth Flagship, the Sustainable Agriculture Flagship was reviewed. The report from the review panel will be submitted to CSIRO in late 2012 and results will be reported in the CSIRO Annual Report 2012–13. Figure 2.4 shows that 60 per cent (16 of 27) of themes that make up the Flagships were within the ‘acceptable’ range for the community / industry dimension of the assessment. This rating is slightly less than CSIRO’s Divisional Science Reviews (for more information see page 44). This result has been attributed to the Flagships’ being a new portfolio or the Flagship activities having less short-term consulting-type work within the portfolio.

<sup>5</sup> Terms of Reference for CSIRO Flagship Reviews.

<sup>6</sup> The seven Flagships reviewed to date include: Climate Adaptation Flagship, Light Metals Flagship (LMF merged with Minerals Down Under and Future Manufacturing on 1 July 2011), Minerals Down Under Flagship, Preventative Health Flagship, Sustainable Agriculture Flagship, Water for a Healthy Country Flagship, and Wealth from Oceans Flagship.

In 2012–13, reviews of the following Flagships are scheduled: Future Manufacturing; Energy Transformed; and Preventative Health. This will commence the start of the second round of reviews for Flagships.

In addition to this process, CSIRO can also commission independent reviews by consultants on the economic, social, environmental and intangible benefits of individual Flagships and/or the National Research Flagships Program as a whole. In 2011–12 no independent reviews were commissioned.

### Flagship publications

In 2011, CSIRO implemented an electronic publications repository, ‘ePublish’. The repository is now able to identify Flagship affiliation from CSIRO publications. However, the repository is still being developed and numbers are, therefore, subject to review.

Table 2.7 shows the number of Flagship publications, by type. Total CSIRO publications are shown in Figure 2.8, page 42.

**TABLE 2.7: NUMBER OF FLAGSHIP PUBLICATIONS BY TYPE, 2011<sup>7</sup>**

PUBLICATION TYPE <sup>1</sup>	NUMBER
Conference papers	461
Journal articles	913
Books / book chapters	86
Technical reports	158
<b>Total</b>	<b>1,618</b>

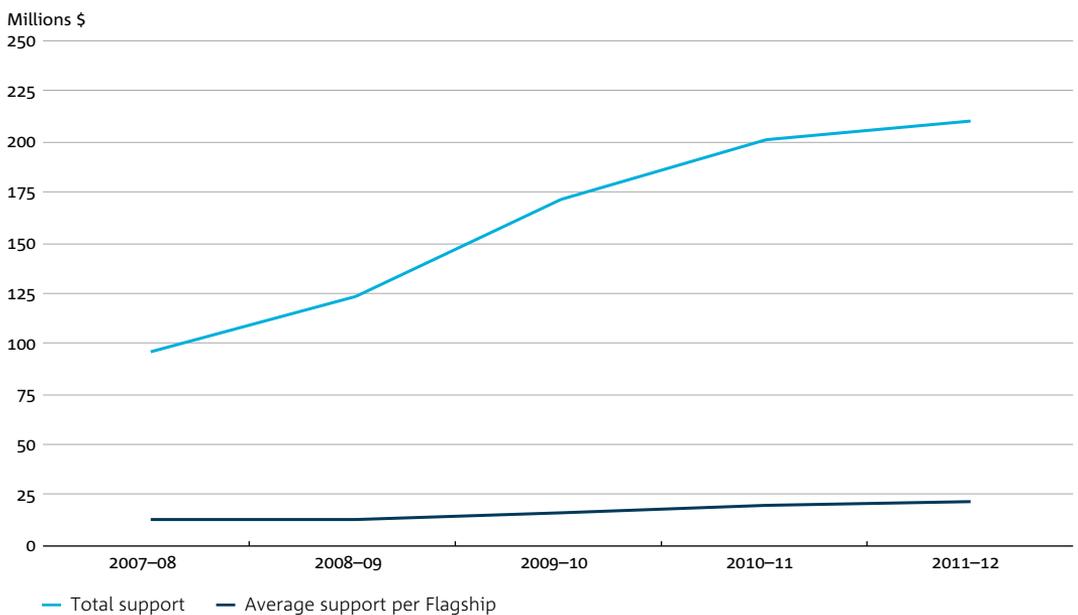
<sup>1</sup> See glossary page 185 for definition of publication types.

### Financial support by Flagship partners

In 2011–12, the National Research Flagship Program increased its revenue from external partners to \$212 million. This amount represents 40 per cent of the Program’s total investment,

up from 20 per cent in 2007–08. The average external revenue received per Flagship has also increased over the same five-year period from \$10 to \$23 million and this growth is shown in Figure 2.5.

**FIGURE 2.5: FINANCIAL SUPPORT FOR FLAGSHIPS FROM EXTERNAL PARTNERS**



<sup>7</sup> Source: CSIRO’s electronic publications repository ‘ePublish’.

## Customer satisfaction

Following a successful pilot, CSIRO has begun implementation of a formal customer satisfaction measurement program to measure customers' 'willingness to recommend CSIRO'. The program will scale up further through the coming months. Baseline results for the Organisation will be available in 2012–13. In parallel, CSIRO will also undertake a series of executive interviews for key customer relationships.

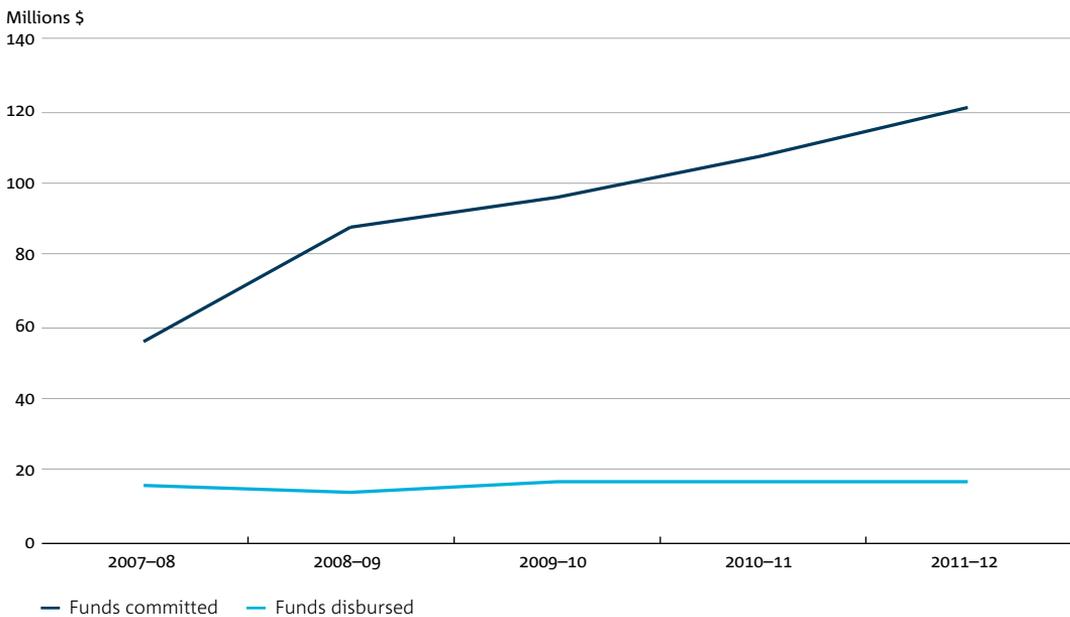
## Investment of the Flagship Collaboration Fund

In 2011–12, investment in the Flagship Collaboration Fund<sup>8</sup> continued as planned with \$17 million disbursed to external research

partners. As at 30 June 2012, over \$121 million has been committed for the life of the Fund, including contractual arrangements to 2014–15. The original government allocation of \$114.25 million is on track to be fully dispersed by 2013–14, see Figure 2.6.

During the reporting year, almost 80 per cent of the dispersed funds were provided to research clusters, including funding for three new clusters involving 11 Australian Universities. The Fund also supported over 20 new projects and visiting fellowships, 30 student scholarships and existing commitments.

**FIGURE 2.6: FLAGSHIP COLLABORATION FUND DISBURSEMENTS AND COMMITMENTS**



<sup>8</sup> For more information see: [www.csiro.au/org/FlagshipCollaborationFundOverview.html](http://www.csiro.au/org/FlagshipCollaborationFundOverview.html)



# Climate Adaptation Flagship

## Analysis of performance

During 2011–12, the Climate Adaptation Flagship contributed to improving the readiness of government, business and society to plan and act for climate impacts. The Flagship engaged closely with stakeholders, providing quality scientific advice to deliver on its goal. This has made a positive contribution to policy decision-making, business and community decision-making, public awareness, and the international aid and development agenda.

This year the Flagship and partners assisted local councils and their communities in south-east Queensland to be more aware of their options to adapt to the impacts of a changing climate. These options included upgrading building codes for new housing for better tropical cyclone preparedness, and behavioural changes relating to the use of air-conditioners to enable local energy suppliers better manage peak energy demand.

Throughout the year, the Flagship provided advice to help guide strategic policy directions for government, as demonstrated in a partnership with the Australian Government Department of Sustainability, Environment, Water, Population and Communities, where CSIRO provided information on the extent of the likely impacts of climate change on biodiversity and the National Reserve System.

As part of the AusAID-CSIRO Research for Development Alliance, the Flagship helped the United Nations World Food Program (WFP) re-assess its priority sub-districts based on vulnerability assessments until 2030. Through the WFP’s partnership with the Indonesian Government’s Department of Food Security, these new priorities form the basis of the 2012 Food and Nutrition Action Plan, and the Strategy and Action Plan for Food Security and Climate Change. These plans were ratified in law by Governor Bupati’s Decrees in April 2012.

### CLIMATE ADAPTATION FLAGSHIP ROADMAP

Theme	1–3 years		4–9 years	10+ years
Pathways to adaptation	Define new approaches to vulnerability and adaptation assessments.	Adaptive capacity of communities and industries assessed; innovative approaches to climate projections.	Identify social and economic adaptation outcome within different sectors and regions.	Biophysical social and institutional dimensions of adaptive capacity more effective for Australia.
Sustainable cities and coasts	Develop methods to assess climate risk and vulnerability in cities and coasts and community adaptive capacity and governance.		Flexible models of utilities, social sciences and governance for climate adapted urban planning and management.	Planning, design infrastructure, management and governance solutions for Australia’s cities and coasts responding to climate change.
Managing species and natural ecosystems	Studies of regions, single species and simple species interactions.	Greater model realism. Focus on threats and tools to assist natural resource managers.	Complex studies of biotic interactions and community ecology. Refine tools for ecosystems managers.	Deliver adaptation options to protect Australia’s marine and terrestrial species and ecosystems from the impacts of climate change.
Adaptive primary industries, enterprises and communities	Improve analysis of interaction between climate drivers and managers’ responses on farms.	Develop technologies and practices for local industry adaptation.	Shifts in vulnerability to climate change understood. Identify when transformational options may be needed.	Adaptation strategies provide economic benefits and improve livelihoods from primary industries, enterprises and communities.

▲  
Current position

**Flagship goal:** To equip Australia with practical and effective options to adapt more effectively to climate change and variability and in doing so create \$3 billion a year in net benefits by 2030.

## The Indian Ocean Climate Initiative

CSIRO scientists, in partnership with the Bureau of Meteorology and the Government of Western Australia (WA), formed the Indian Ocean Climate Initiative (IOCI) in 1997. The IOCI partnership came from a need to better understand and plan for the dramatic and continuing rainfall reductions in south-west Western Australia. At the time, the role of the Indian Ocean on Western Australia's climate was poorly understood.

From the 1980s, south-west WA's drying trend led water agencies to examine the need to secure alternative water sources. Crucially, independent and objective research from the IOCI showed this drying was not temporary or cyclical, hastening and strengthening the case for a seawater desalination plant. In November 2006, as a result of IOCI research, Australia's first large-scale desalination plant was commissioned. This research also assisted the WA Government, in July 2011, to make an informed decision to approve a \$450 million expansion of south-west WA's second desalination plant to meet the region's urgent need for a new water source.

IOCI research is informing decision-makers on water supply and in the agriculture, mining and petroleum, health and safety sectors. In the agricultural sector, for example, the information provided by the IOCI has been adopted to demonstrate the best use of land in different parts of south-west WA under future climate scenarios. The WA Department of Agriculture and Food provides this information to farmers to help them make informed investment decisions.



Decreasing rainfall has prompted new adaptation measures in south-west WA. This includes the city of Perth, where IOCI research played an important role by hastening and strengthening the case for Australia's first major desalination plant. Image: iStockPhoto

# Energy Transformed Flagship

## Analysis of performance

The Energy Transformed Flagship has been working on one of Australia’s key challenges – to mitigate climate change. Finding the most cost-effective ways to reduce emissions from the energy and transport sectors (which contribute two-thirds of Australia’s emissions), while maintaining energy security, has been the key priority.

To meet these challenges, the Flagship is developing Australian specific technologies to reduce carbon emissions. These technologies include algal biodiesels, biofuels from waste biomass, renewable energy storage solutions, electric vehicle-to-home integration, concentrated solar thermal and photovoltaic systems.

In 2011–12, the Flagship delivered a world-first analysis of one of solar energy’s biggest challenges: intermittency (the variability of sunshine due to cloud cover). Funded by the Australian Solar Institute, the study found that there are no insurmountable barriers to increasing the use of large-scale solar energy in Australia’s electricity grid.

In March 2012, the Flagship, in partnership with the Department of Climate Change and Energy Efficiency, delivered CSIRO EnergySavers to low income and financially constrained households. The program provides householders with advice and information on how to reduce their energy bills and greenhouse gas emissions.

As further demonstration of our work in clean, low-emission energy, the Flagship, in collaboration with a number of international and national partners, began work on a range of demonstration-scale concentrated solar thermal technologies, including solar fuels, high temperature storage, solar air turbines and steam turbines.

### ENERGY TRANSFORMED FLAGSHIP ROADMAP

Theme	1–3 years	4–9 years	10+ years
Carbon futures	Develop models and reports to inform policy, industry and research. Undertake social attitude mapping. Hold stakeholder energy forum.	Hold transport sector stakeholder forums. Undertake longitudinal and larger population social analysis studies; commercialise software. Initiate integrated carbon assessment service.	Deploy an integrated energy, water, food and carbon assessment service to help Australia identify the least cost and risk transition pathways to a prosperous and secure low carbon future.
Sustainable stationary energy and transport	Develop technologies for low-cost solar power production and energy storage. Prioritise potential fuel crops for large-scale, sustainable biofuels production.	Demonstrate significant technologies at pilot scale, with industry and government support.	Drive the cost-effective take-up of renewable electricity and transport fuels in Australia to 2020 and beyond and maximise the long-term renewables uptake to 2050.
Local energy systems	Develop low-emission distributed energy technologies. Identify and begin engagement with partners.	Develop distributed generation and efficient options model to inform government and industry. Commercialise technologies.	Reduce greenhouse gas emissions by driving the uptake of distributed energy solutions, demand reduction and energy efficiency measures to 2020.

▲  
Current position

**Flagship goal:** To develop, demonstrate and ensure deployment by 2020 of integrated low carbon pathways for Australia and alternative stationary and transport energy solutions that realise a reduction of Australia's carbon dioxide equivalent emissions greater than 20 million tonnes per annum by 2030 and greater than 50 million tonnes per annum by 2050.

### Solar cooling Australia's homes

Air conditioning our homes and offices contributes around seven per cent to Australia's greenhouse gas emissions and places a heavy demand on our electricity supplies. To address this challenge, the Energy Transformed Flagship has developed ground-breaking solar cooling technology.

Solar cooling is powered by the heat of the sun and uses a minimal amount of electricity compared to conventional cooling systems. CSIRO's new technology consists of a desiccant wheel which removes moisture from incoming hot, humid air making it cooler so that it can be used immediately or chilled further via an evaporative cooler. The system is a low-emission, low-cost alternative to electricity powered air-conditioners.

Funded by the New South Wales Government, the Flagship installed Australia's first commercial scale solar cooling system at the Hunter Institute of Technology, New South Wales in September 2011. The system provides the Institute with cool air in summer and heating in winter, and is projected to save 5,000 tonnes of greenhouse gas emissions over the next decade.

In November 2011, the National Heating Ventilation and Air Conditioning Performance Test Facility, located at CSIRO's Energy Centre in Newcastle, New South Wales, was officially opened. The commercial facility provides state-of-the-art testing facilities for industry and government to evaluate the performance of conventional and solar-powered air-conditioning systems.

Funded by the Australian Solar Institute, CSIRO and industry partners will be investigating the complete benefits of solar cooling technology in terms of energy savings, reducing peak demand and the financial benefits. As part of the study, solar cooling systems will soon be installed in some Australian homes.



An artist's impression of a solar cooling system.

# Food Futures Flagship

## Analysis of performance

In 2011–12, the Food Futures Flagship continued to deliver results and significant impact in a number of areas, supported by partnerships and collaborations with industry and research organisations.

The Flagship is continuing to provide economic benefits to the Australian aquaculture industry through partnerships in selective breeding and aquafeed technology. During the reporting year, the Atlantic salmon selective breeding program was commercialised and industry adoption of the elite Black Tiger prawn breeding program expanded. This saw a 30 per cent increase in the number of aquaculture ponds stocked with the prawns.

First commercial farm trials were held of the Flagship’s novel bioactive aquafeed (Novacq™). The trials demonstrated that the new aquafeed ingredient increased prawn growth rates by 20 per cent, offering significant potential to reduce reliance on fish meal for aquafeed, easing the pressure on global fish stocks.

The Flagship contributed to the grains industry and the health of Australians by progressing the development of grains that offer increased health benefits in the form of omega-3 oils, dietary fibre and higher levels of resistant starch. This was supported by new evidence supporting the bowel health benefits of resistant starch. Additionally, the range of consumer products that contain the high resistant starch grain BARLEYmax™ has expanded beyond breakfast cereals to include flat-bread wraps.

The Flagship’s development of biosensor technology has progressed, with a US patent lodged for a method that can detect an odour continuously. This will allow instant odour monitoring for applications including disease detection in humans, and safety and quality evaluation throughout the food supply chain.

### FOOD FUTURES FLAGSHIP ROADMAP

Theme	1–3 years	4–9 years	10+ years
Future grains	Optimise carbohydrate in grains, optimise omega-3 oils in plants and investigate genetic traits for improved quality and nutrition.	Combine beneficial traits for farmers and consumers, breed and commercialise long chain omega-3 oils in plants and commercialise quality and nutrition traits.	Increase returns to Australia by \$550 million per annum through enhanced grain quality attributes and human health benefits.
Breed engineering	Animal management systems adopted and breeding technology developed with commercial partners.	Industry adoption of testes cell transfer techniques, success of aquatic breeds and novel feeds and optimal genetics in livestock and aquaculture.	Boost the value of Australia’s animal-based food industries by \$350 million per annum for beef and \$550 million for seafood.
Quality biosensors <sup>1</sup>	Development of test technology, odours predicting grape and wine quality identified.	Biosensor developed and adoption commenced in defence domain. Benchtop prototype completed and field prototype commenced. Applications for food safety and quality in development.	Apply technology to food safety and process control, clinical diagnosis, biosecurity and security/law enforcement, delivering value in excess of \$750 million per annum.

▲  
Current position

1 The Quality Biosensors Theme has changed to reflect the wider applicability of the technology.



**Flagship goal:** To transform the international competitiveness of the Australian Agrifood sector, adding \$3 billion in annual value, by applying frontier technologies to high potential industries.

### Increasing yield and oil production in plants

The Food Futures Flagship has developed two new technologies that will enable the production of more food, potentially having a profound impact on agricultural food, feed and feedstock production globally.

Global agricultural production needs to nearly double by 2050 if current population trends continue and there is a need to increase yield in crop species and plant based oil production to meet this demand. Food Futures Flagship researchers have identified two genetic modification techniques that offer the potential to significantly increase the biomass, grain and oil production of crops.

In a world-first, Flagship researchers, with co-funding from the Grains Research and Development Corporation, have discovered that turning off the glucan water dikinase gene increases wheat yield by up to 30 per cent in glasshouse trials. Traditional plant breeding in wheat usually results in a one to two per cent increase in yield each year, so an increase in yield of ten per cent or more has enormous implications for food security globally.

Additionally, the global demand for oil from plants will double within 20 years to meet increasing food, feed and industrial requirements. This new demand will be difficult to meet using current plant sources. By using genetic modification, Flagship researchers have identified a unique way to significantly increase the amount of oil produced in the seeds and leaves of plants.

This new technique can be applied in common oilseed plants, such as canola, as well as in the leaves of plants not currently regarded as significant oil producers. Each single per cent increase in oil production is estimated to be worth \$300 million globally, and this new technology provides an opportunity to significantly expand the plant oil industry.

By combining these two new technologies we hope to see an increase in the yield and oil production of plants, which will contribute significantly to global food security.



**Food Futures Flagship researchers working with experimental canola in a Black Mountain glasshouse in Canberra.**

# Future Manufacturing Flagship

## Analysis of performance

Throughout 2011–12, the Future Manufacturing Flagship has made significant progress toward its goal of enabling the uptake of resource efficient, clean and transformational technologies by the manufacturing industry. A testament to this is our successful partnership with Boeing who are now using our topcoat reactivation technology in more than 850 of its new aircraft worldwide.

Our expertise in advanced ceramics was crucial to the establishment of a world-competitive armour manufacturing facility in Bendigo, Victoria. The Flagship's leadership in growing an Australian additive manufacturing industry is also assisting local businesses in becoming suppliers of titanium products for the aerospace industry.

Our strategic industry clusters and alliances with companies such as Orica, General Electric and Boeing are equipping Australian businesses with technologies that help them access global markets.

As a Trusted Advisor, we are also working with industry and government agencies to provide technology-based information and leadership to policy development through initiatives such as the Australian Sustainable Manufacturing Initiative; Green Growth Partnerships Program; Manufacturing Trends 2020 and the Technical Working Group of the Prime Minister's Manufacturing Taskforce.

The Flagship is delivering benefits through the development of better products, processes and services. Through effective partnering, we are helping Australian firms deliver to global markets and create wealth for Australia.

### FUTURE MANUFACTURING FLAGSHIP ROADMAP

Theme	1–3 years	4–9 years	10+ years
Advanced engineered components	Materials and process development for sustainable transport solutions.	Commercialise emerging technologies.	Growth in the Australian advanced engineered components sector.
Advanced fibrous and protective materials	Establish relationship clusters in filtration and defence, personal protection and environment sectors.	Commercialise first and second generation products.	Growth in the Australian advanced textiles manufacturing sector.
Flexible electronics	New materials discovery, device prototype optimisation and ruggedisation and scale up.	Translate discoveries to create vibrant manufacturing industries based on flexible electronics.	Creation and growth of world-leading Australian companies in flexible electronics.
Sustainable materials	Develop technologies for economically and environmentally sustainable construction materials and processes.	Deploy new platform technologies in partnership with industry.	Sustainable environmentally conscious manufacturing in Australia.
Titanium technologies <sup>1</sup>	With industrial partners, advance technology readiness for new titanium production and manufacturing processes.	Commercialise new processes and guide technologies to production levels, manage and strengthen industry relationships; build direct manufacturing capability for domestic industry.	Creation of a world-scale titanium industry for Australia.

▲  
Current position

1 The Titanium Technologies Theme joined the Future Manufacturing Flagship on 1 July 2011 following the merger of the Light Metals Flagship with the Minerals Down Under and Future Manufacturing Flagships.

**Flagship goal:** To create \$2 billion of additional annual value for Australia’s manufacturing industry by 2025 through the development and application of resource efficient, clean and transformational technologies.

### CSIRO’s expertise helps manufacturing company Textor

The Future Manufacturing Flagship has been working with Textor Technologies, a family-owned Victorian manufacturing company, to consolidate Textor’s position as a key supplier of specialised fluid transfer fabrics to world markets. With assistance from a CSIRO textile and fibre specialist, Textor Technologies have developed more comfortable hygiene products.

Hygiene products such as baby nappies, adult incontinence protection, feminine hygiene and wound care, are worth billions of dollars worldwide. With CSIRO’s expertise and world-class textile research facilities, Textor has developed fabrics with tailored properties to improve the product – in this case, products which are softer and keep the wearer drier for longer.

This joint project is helping Textor to grow its business by developing competitive advantages for its product range. Textor is also using the Flagship’s extensive capacity in materials analysis and its processing facilities to help with screening and process development.

Textor Technologies is an Australian small-to-medium enterprise that designs and produces non-woven textiles engineered for specific purposes. The company produces an array of products used in applications for the hygiene, health care, wipes, industrial fabrics, and food packaging markets. As a leader in leaner, smarter manufacturing processes, Textor is influencing and shaping Australian manufacturing as companies look to develop more efficient and competitive production processes.

Textor is supported by the Future Manufacturing Flagship and the Department of Industry, Innovation, Science, Research and Tertiary Education’s Enterprise Connect Researchers in Business Program, which enables small-to-medium sized businesses to access research skills.

In addition to the Researchers in Business project, Textor’s collaboration with CSIRO has resulted in a \$6 million project aimed at establishing a nanofibre production and processing facility within Textor. This project has a longer-term focus and will generate a new range of products within five years.



CSIRO’s expertise in textile and fibre technology is helping to make hygiene products more comfortable.  
Image: Dreamstime

# Minerals Down Under Flagship

## Analysis of performance

During 2011–12, the Minerals Down Under Flagship focused on delivering research outcomes that created increased opportunities for the Australian minerals industry and produced new detection tools that facilitated mineral discovery.

In the mining sphere, automated location and navigation technology devices for machinery are being commercialised by Australian company, Minetec, with the first commercial systems to be launched in 2013.

In collaboration with industry, the Flagship is gaining significant traction in the commercialisation of mineral processing activities including processing gold without the use of cyanide.

Work on a new nickel laterite process is on track to enable the economic processing of millions of tonnes of low-grade nickel laterite ores, potentially making \$350 billion of previously uneconomic ore viable.

The Flagship and partners are trialling a groundbreaking low-emission integrated steel making process, one of the few technologies able to reduce carbon emissions at minimal cost to smelters. Estimated savings to industry are \$42 billion over the next 20 years, annual greenhouse gas reductions of 81 million tonnes and annual savings in fresh water use of 146 gigitalres.

### MINERALS DOWN UNDER FLAGSHIP ROADMAP

Theme	1–3 years	4–9 years	10+ years
Driving sustainability through systems innovation	<ul style="list-style-type: none"> <li>Develop concepts to reduce greenhouse gas and water use.</li> <li>Assess the implications of plausible futures.</li> </ul>	<ul style="list-style-type: none"> <li>Proof of concept for new eco-efficient technologies.</li> <li>New planning tools to support social licence to operate.</li> </ul>	<ul style="list-style-type: none"> <li>Demonstration of whole system approach.</li> <li>Social negotiation tools embedded in technology and project development.</li> </ul>
Discovering Australia's mineral resources	<ul style="list-style-type: none"> <li>Identify new exploration tools.</li> <li>Enable data interoperability.</li> <li>Build multi-party collaborations.</li> </ul>	<ul style="list-style-type: none"> <li>New 3D exploration tools developed and applied to buried deposits and new Greenfield sites.</li> </ul>	<ul style="list-style-type: none"> <li>3D visualisation, modelling and targeting embedded as an industry standard leading to new discoveries.</li> </ul>
Transforming the future mine	<ul style="list-style-type: none"> <li>Engagement with industry to develop innovative mining concepts and establish investment.</li> </ul>	<ul style="list-style-type: none"> <li>Field trials of novel automated continuous selective mining systems and integrated light weight drill systems.</li> </ul>	<ul style="list-style-type: none"> <li>Adoption of new drilling, rock extraction and sorting systems.</li> <li>A vibrant mining technology and services sector.</li> </ul>
Securing the future of Australia's carbon steel materials industry	<ul style="list-style-type: none"> <li>Develop infrastructure for precision iron ore and coke characterisation.</li> <li>Build relationships with industry.</li> </ul>	<ul style="list-style-type: none"> <li>Beneficiation and agglomeration process improvements being commissioned with resulting efficiency gains.</li> </ul>	<ul style="list-style-type: none"> <li>Low-grade iron ores gaining traction in the Australian export market.</li> </ul>
Creating wealth through advanced processing technologies	<ul style="list-style-type: none"> <li>Laboratory testing of new ore characterisation, ore concentration and mineral/metal extraction techniques.</li> </ul>	<ul style="list-style-type: none"> <li>Continuous improvements of existing plant.</li> <li>Pilot plant and field trials of new techniques.</li> </ul>	<ul style="list-style-type: none"> <li>New ore reserves on-stream. In-situ leaching viable.</li> <li>Australian mineral processing technology preferred.</li> </ul>
Transforming productivity through on-line analysis	<ul style="list-style-type: none"> <li>Collaborative projects for concept development.</li> <li>Technology trials with industry.</li> </ul>	<ul style="list-style-type: none"> <li>Industry partnerships for platform development.</li> <li>Spin-offs and commercialisation.</li> </ul>	<ul style="list-style-type: none"> <li>On-line analysis embedded in Australian operations with significant efficiency gains and reduced cut-off grades.</li> </ul>
Growing Australia's light metals industry <sup>1</sup>	<ul style="list-style-type: none"> <li>Large laboratory testing of new metallurgical processes.</li> <li>Working closely with industry on process optimisation.</li> </ul>	<ul style="list-style-type: none"> <li>Pilot plants for new metallurgical processes.</li> <li>Efficiency gains being delivered to existing industries.</li> </ul>	<ul style="list-style-type: none"> <li>Australia's light metal technologies preferred.</li> <li>Australia's light metal industries global leaders in efficiency.</li> </ul>

### Current position

1 Growing Australia's Light Metals Industry Theme joined Minerals Down Under Flagship on 1 July 2011 following the merger of the Light Metals Flagship with the Minerals Down Under and Future Manufacturing Flagships. From 1 July 2012, the number of themes will be consolidated from seven to five.

**Flagship goal:** Delivering science and technology options for the discovery and efficient development of Australia’s mineral resource endowment that will lead to \$1 trillion in-situ value by 2030 and enable flow-on benefits to the wider national economy.<sup>1</sup>

## A new national resource for mineral explorers

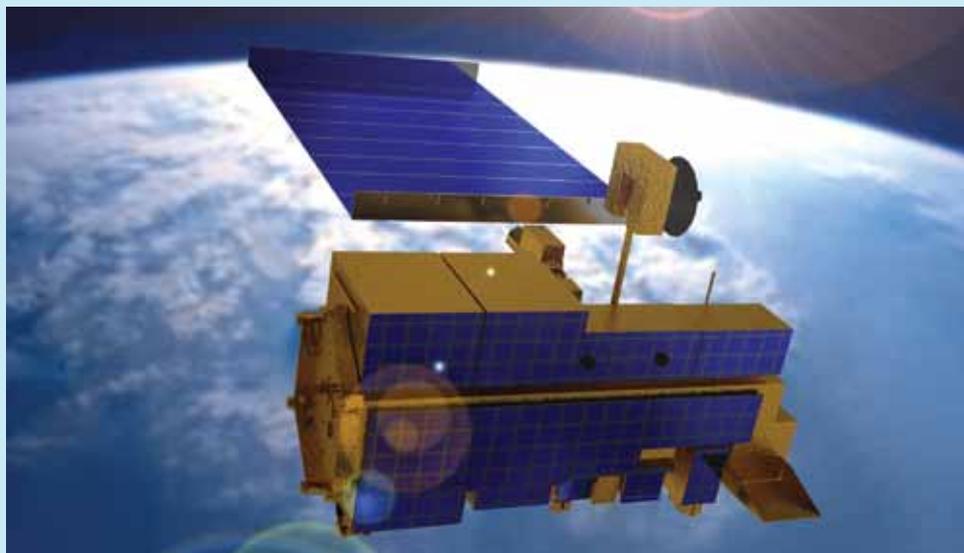
In a world-first, CSIRO has used country-wide satellite data to detail the surface mineralogy of the Australian continent.

By accessing a ten-year archive of raw Advanced Spaceborne Thermal Emission and Reflection (ASTER) satellite data collected by NASA and the Japanese Government’s Earth Remote Sensing and Data Applications Center, CSIRO scientists have developed software that has transformed that data into a continent-wide suite of mineral maps.

The ASTER maps provide a Google-like ‘zoom’, which allows users to view images from thousands of kilometres wide down to just a few kilometres. This will fill a critical gap in geoscience information required by mineral explorers to help them better target drilling programs to improve exploration outcomes and reduce costs.

The maps are the first step in empowering geoscientists with spatially-comprehensive mineral information. They have the potential to transform mineral exploration in Australia, leading to valuable new mineral resource discoveries. The satellite data and maps can also be used to monitor links between geology and the biosphere in applications as diverse as soil science, agriculture and environmental mapping. They are already changing the way that geoscientists look for mineral deposits by providing more accurate and detailed information than ever before.

This national resource builds on a collaboration that spans over 20 years with Japanese space agencies and NASA, as well as industry, Geoscience Australia and each of the State and Territory geological survey organisations.



Japanese ASTER sensors on board the US Terra satellite platform. Image: NASA

<sup>1</sup> Following consultation with stakeholders, our goal was modified in July 2012 in response to changing needs, to support the growth of the Australian economy.

# Preventative Health Flagship

## Analysis of performance

During the reporting year, scientists have made considerable inroads towards the Flagship’s objectives in the early detection of, and protection against, disease and cancer.

Working with our Australian Imaging, Biomarkers and Lifestyle (AIBL) partners, CSIRO has identified plasma biomarkers that can help distinguish people suffering from Alzheimer’s disease, from those with healthy brain function. Alzheimer’s is the most feared disease of our ageing population and the most common form of dementia. Approximately 280,000 Australians are living with dementia and this is projected to increase to one million by 2050 as our population lives longer. The new biomarkers are a first step towards developing methods for early detection of the disease. From there, drug and/or lifestyle interventions can be undertaken to prevent, delay or slow progression. Toward this end, early research by CSIRO and AIBL collaborators has identified elements of a Mediterranean diet that has protective benefits.

Additionally, CSIRO and the Australian e-Health Research Centre, working with the McCusker Alzheimer’s Research Foundation and AIBL, are investigating whether the characteristics of blood vessels in the retina at the back of the eye might serve as a possible early indicator for Alzheimer’s.

Our work into stroke prevention continues, with CSIRO and STroke, imAging, pRevention and Treatment (START) collaborators identifying blood and imaging biomarkers that measure the time since the patient experienced a stroke. This information could substantially increase a patient’s eligibility for therapies that have been shown to dramatically improve the chances for a full recovery, with the potential to significantly reduce or prevent long-term disability.

Despite a significant increase in the levels of fibre in Australian diets in the last 20 years, incidences of bowel cancer remain high with approximately 90 people dying from the disease each week. CSIRO scientists are continuing research into the health benefits of resistant starch, which can protect against bowel and colon cancer.

### PREVENTATIVE HEALTH FLAGSHIP ROADMAP

Theme	1–3 years	4–9 years	10+ years
Colorectal cancer and gut health	New knowledge, early detection and prevention of colon and rectal cancer and inflammatory bowel disease.	Translation into marketable diagnostics and protective foods.	Reduced morbidity and mortality from colon and rectal cancer and inflammatory bowel diseases in Australia.
Neurodegenerative diseases	New knowledge about the aetiology and early detection of neurodegenerative disease.	Develop and commercialise neuro protective agents and biomarkers for early detection and prevention.	Delay the onset of Alzheimer’s and other neurodegenerative diseases in Australia by five years.

▲  
Current position

**Flagship goal:** To improve the health and wellbeing of Australians and save \$2 billion in annual direct health costs by 2020 through the prevention and early detection of chronic diseases.

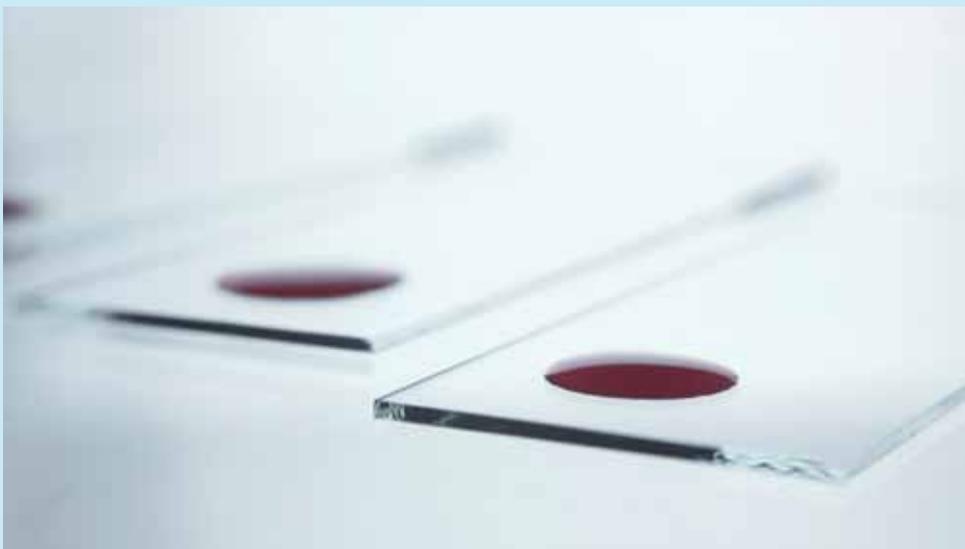
### New blood test for bowel cancer

CSIRO and partners have identified new genes that show identifiable changes in the blood of people with bowel cancer. A new cost-effective blood test is being developed that will signal the early stages of the disease. The blood test could save thousand of lives by supplementing existing screening programs and encourage those at risk to have a colonoscopy.

The new blood test is currently being trialled with patients from Australia, the United States and Europe. Preliminary results have shown excellent detection rates for bowel cancer, with a high degree of accuracy in samples drawn from people at high-risk.

While the results are highly promising, further research is needed before a blood based test of this nature is available in the community. Scientists are collaborating with other research groups, both locally and internationally, to ensure that the test is undertaken under the same conditions in different laboratories. This will allow further evaluation of the test in larger numbers of blood samples drawn from a diverse population, whose disease status is not previously known.

A blood test may be more acceptable to the public than the current stool-based analysis. If it is introduced as a screening test, it should significantly improve patient participation in bowel cancer screening programs. This blood test is the product of a close alignment of clinical research using advanced genomics, epigenetics and biological statistics and is the result of over five years of scientific collaboration between CSIRO, Flinders University and Australian biotechnology company, Clinical Genomics.



**Blood tests for bowel cancer should significantly increase participation in screening programs.**  
Image: iStockPhoto

# Sustainable Agriculture Flagship

## Analysis of performance

During 2011–12, the Sustainable Agriculture Flagship reached several milestones on its path towards its goal. In addressing the carbon emissions challenge, the Flagship played an instrumental role with the Department of Climate Change and Energy Efficiency informing the development and implementation of the Carbon Farming Initiative. This initiative will allow farmers and land managers to voluntarily participate in the carbon market by using CSIRO tested techniques to accurately measure changes in their greenhouse gas emissions. The Flagship also launched an \$8 million major new research cluster, along with six other Australian universities, targeting the measurement and reduction of emissions from livestock in northern Australian cattle.

On the productivity front, the Flagship was a key partner in the development of several farmer decision support tools including the ‘5 Easy Steps’ guide for sustainable phosphorus application and the Fertiliser Optimiser, which allows farmers to calculate their return on investment from adopting precision agriculture techniques. Tools like these have contributed to the increase in adoption of precision agriculture from 5 per cent to 30 per cent Australia-wide.

### SUSTAINABLE AGRICULTURE FLAGSHIP ROADMAP

Theme	1–3 years	4–9 years	10+ years
Reducing net greenhouse gas emissions while increasing storage of new carbon in our lands.	Develop greenhouse gas mitigation practices and technologies, measurement, accounting and bio-sequestration options.	Total system greenhouse gas outcomes for different management, history, climate and soil combinations quantified with defined uncertainty and co-benefit assessment.	New carbon sinks and mitigation practices created within profitable and sustainable agricultural system.
	Support national policy decisions on land use management for carbon storage and greenhouse gas mitigation.	Conduit for science and integration for industry and government.	National dialogue, policy and action are informed by robust science.
Advancing agricultural productivity and environmental health.	Identify challenges and prospects for food and fibre productivity increases in key industries, regions and systems.	Direct links between genetics, breeding and farming systems research underpin accelerated improvements in food and fibre productivity.	Step-change in productivity achieved via industry adoption of agro-ecological innovations for ‘smart’ food and fibre production systems.
	Characterise resource and labour-use, soil and water constraints to sustained productivity.	Integrated whole-farm analyses support diverse sustainable enterprise options for efficient resource management.	More sustainable production practices adopted with enhanced resources-use efficiency.
	Evaluate agro-ecological tradeoffs in farming systems to improve productivity and natural resource management outcomes.	Assess environmental impacts of emerging productivity and mitigation practices, technologies and policies.	New markets developed and in use for effective on-farm environmental and biodiversity stewardship schemes.
Informing land use planning, policy and natural resource management.	Observation of current status and historic change in key land management drivers.	Develop life-cycle based sustainability assessments for agri-food value chains.	Multi-scale temporal assessment of land use change.
	Enhance national soil and terrain data systems.	Triple-bottom-line modelling framework for land use systems.	International system for forest and carbon tracking.
Addressing global food and fibre security challenges through partnerships at home and abroad.	Deliver enhanced science and impact via an integrated approach to international project portfolio.	Deepen partnerships with international R&D institutions leading to enhanced capacity building.	Monitoring and evaluation confirm realised sustainable livelihood benefits in target regions.

▲  
Current position

**Flagship goal:** To secure Australian agriculture and forest industries by increasing productivity by 50 per cent and reducing carbon emission intensity by at least 50 per cent between 2010 and 2030.

## Record wheat yield for Queensland

CSIRO, in collaboration with the Grains Research and Development Corporation (GRDC), has developed a set of new management guidelines to assist farmers produce record wheat yields in irrigated cropping areas of Queensland and northern New South Wales.

Traditionally, irrigated wheat crops thrive early in the season, becoming thick and lush in the warm and wet conditions. However, these lush crops can become too tall, with weak stems and roots, and are more likely to bend and fall over once mature. Fallen (lodged) crops are difficult to harvest and a farmer's economic loss from a lodged crop can be significant. In 2008, \$20 million was lost due to widespread lodging in these areas.

CSIRO's new guidelines provide farmers with detailed advice on how to conduct soil tests; optimise sowing time and seeding rate; and how to choose which variety of crop to sow. They provide advice on irrigation scheduling and the best time to apply nitrogen fertiliser with the aim of reducing lodging and boosting wheat yields.

In 2012, a Queensland farmer, whose crop was managed according to the guidelines, recorded the highest commercial wheat yield ever in the State. Following CSIRO's recommendations, the farmer sowed 60 hectares of wheat in June 2011 and, in November 2012, the crop yielded 8.2 tonnes per hectare, two tonnes more than he had ever achieved using traditional methods.

'Next year we'll use the guidelines again to see if we can achieve similar yields. This crop has really helped us to bounce back from the floods.' Hamish Bligh, farmer.



Hamish Bligh and family followed a strict irrigation regime in accordance with the Achievable Yield Guidelines prepared by CSIRO and funded by GRDC. Image: Clarisa Collis, Coretext, courtesy of the GRDC.

# Water for a Healthy Country Flagship

## Analysis of performance

In 2011–12, the Water for a Healthy Country Flagship’s research informed water policies and strategies across Australia, including leading a review of the science behind the proposed Murray-Darling Basin sustainable diversion limits (more on page 37).

During the year, CSIRO published *Water: Science and Solutions for Australia*, which provides comprehensive information on Australia’s water challenges and prospects. The book aims to assist government, business and the wider community make informed decisions about the challenges of water resource management.

In late 2011, CSIRO, the Australian National University, the Bureau of Meteorology, Geoscience Australia and the Defence Imagery and Geospatial Organisation, completed a computer model of Australia’s ground surface topography and river networks, providing new information on Australia’s terrain.

This financial year, CSIRO and Australia Pacific LNG launched the \$14 million Gas Industry Social and Environmental Research Alliance. The Alliance undertakes research into the environmental and socio-economic impacts of gas development.

The five-year Urban Water Security Research Alliance, a partnership between CSIRO, the Queensland Government, Griffith University and the University of Queensland finished in 2012. The Alliance helped inform technical management in south-east Queensland’s water industry and informed policy, guidelines, regulations and education.

### WATER FOR A HEALTHY COUNTRY FLAGSHIP ROADMAP

Theme	1–3 years	4–9 years	10+ years	
Urban water	Develop new tools and technologies for sustainable integrated management of water systems and infrastructure from city/regional to household level.	Inform state and national urban water policy through applied research of integrated urban water systems technologies.	Decision support systems, system performance knowledge, and new water management technologies to plan and deliver sustainable integrated urban water services.	To provide socially acceptable, affordable environmentally beneficial management solutions for Australia’s urban water systems.
Integrated water information systems	In partnership with the Bureau of Meteorology, develop water reporting and forecasting tools. Develop sensor networks to improve real-time monitoring.	Enable water information interoperability through research investments in standards development, web service integration, semantic web and model interoperability.	Widely accessible national water information network based on open standards. Reporting and forecasting tools used in water demand regions.	Establish the platform for an Australia-wide network of integrated water information systems that deliver water accounts, assessments and forecasts.
Healthy water ecosystems	Establish a network of integrated models and evaluation tools and embed these in the adaptive management of high priority water ecosystems.	Inland and coastal water ecosystems managed through the use of integrated knowledge platforms.	Significantly reduced long-term impacts of pollutants and changed flow regimes in priority water ecosystems.	To provide the knowledge to protect or restore Australia’s major water ecosystems while enabling sustainable use of water resources.
Regional water	Enable water savings in irrigation systems, and establish improved water efficiency and sustainability through improved surface and ground water management options.	Develop options for improved institutional water use arrangements and evaluation of their economic, social and environmental consequences.	Achieve greater water supply certainty, enhanced substitution options, and improved productivity through integrated management of river basins and aquifers.	To provide systems knowledge and analysis tools for river basins and aquifers to ensure water security for all users.

▲ Current position

**Flagship goal:** Consistent with Australia’s national interest, develop science and technologies that improve the social, economic and environmental outcomes from water, and deliver \$3 billion per year in net benefits for Australia by 2030.<sup>1</sup>

### Delivering a sustainable future for the Murray-Darling Basin

In 2011, CSIRO was commissioned by the Murray-Darling Basin Authority (MDBA) to assess the environmental and economic benefits of returning 2,800 gigalitres of water per year to the Murray-Darling Basin.

This work identified the substantial environmental benefits that could be achieved from recovering this water, including improved water quality, healthier river environments, healthier red gum forests, and increased numbers of native fish and water birds. Although not all benefits could be given a monetary value, the value of those which could was estimated to be between \$3 billion and \$8 billion.

The largest economic benefits would come from improved ecosystem services — the benefits provided by natural ecosystems, such as maintenance of water quality and habitat to the Murray Mouth, Lower Lakes and Coorong, South Australia. Carbon sequestration (capturing carbon dioxide) from healthier forests across the river ecosystems is also worth hundreds of millions of dollars.

This work has helped the MDBA evaluate the proposed Basin Plan and has informed community discussions about the Plan.



**Headings Cliffs on the Murray River, South Australia. In 2011–12, CSIRO delivered two reports to inform water management in the Murray-Darling Basin.**

<sup>1</sup> The goal was modified in late 2011 to reflect growing international focus and to provide a more balanced representation of the benefits provided from water and water-dependent ecosystems.

# Wealth from Oceans Flagship

## Analysis of performance

The Flagship led an international research team to account for all the contributions, such as glacial melting and thermal ocean expansion, that contribute to the rise in sea-levels globally. This research resolved the issue that the sum of these contributions has been less than the observed rise in sea-level over recent decades. The team used new and updated estimates, including a new estimate of groundwater depletion, to provide a more accurate estimate of rising sea-levels. This enabled the team to balance the results in actual observed sea level rise from 1972 to the present. More accurate estimates can be used for planning and adaptation, such as coastal planning.

As part of the South-East Queensland (SEQ) Healthy Waterways Partnership, CSIRO has developed a next generation 3D model of Moreton Bay. The model will assist SEQ to manage, more effectively, the water catchments that feed into the bay and will help planners to incorporate climate change scenarios into their plans to minimise environmental impacts. This 3D model is the first of its kind and enables government and planning authorities to look at and plan for future scenarios. The model is also proving useful for assessing the future impacts of the 2011 floods on Moreton Bay.

A scientific plan to rebuild the southern bluefin tuna stock was accepted by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). The management approach underpinning the plan was developed by CSIRO in collaboration with the Australian Bureau of Agricultural and Resource Economics and Sciences, and members of the CCSBT Scientific Committee in response to a need to rebuild the stock to 20 per cent of its unfished level by 2035. It is the first time such a management approach has been adopted and implemented for any of the internationally managed tuna and will lead to rebuilding of the stock, while increasing the economic value of the fishery.

### WEALTH FROM OCEANS FLAGSHIP ROADMAP<sup>1</sup>

Theme	1–3 years	4–9 years	10+ years
The dynamic ocean	<ul style="list-style-type: none"> <li>Synoptic forecasting system for major marine industries delivered (BLUElink 3).</li> </ul>	<ul style="list-style-type: none"> <li>Deliver littoral zone forecasting system for defence and industry applications.</li> </ul>	<ul style="list-style-type: none"> <li>National, seamless near-real ocean prediction and forecasting system operationalised.</li> </ul>
Our resilient coastal Australia	<ul style="list-style-type: none"> <li>Coastal management strategy evaluation system implemented and operational in three regions nationally.</li> </ul>	<ul style="list-style-type: none"> <li>Integrated observation modelling and visualisation system (eReefs) guiding management of the Great Barrier Reef Marine Park.</li> </ul>	<ul style="list-style-type: none"> <li>National shelf-scale hydrodynamic model (BROWNlink) nationally implemented and used for oceanographic services.</li> </ul>
Sustainable ocean ecosystems and living resources	<ul style="list-style-type: none"> <li>CSIRO R&amp;D underpinning marine bioregional plans and National Representative System of Marine Protected Areas.</li> </ul>	<ul style="list-style-type: none"> <li>Adoption of CSIRO marine incident emergency response system.</li> </ul>	<ul style="list-style-type: none"> <li>Operationalisation of a National Ocean and Coastal Information System, as part of Australia's National Environmental Information System.</li> </ul>

▲  
Current position

<sup>1</sup> The Flagship underwent an impact review in 2010. Recommendations included a stronger focus on future project investment to enable successful uptake by key end users. The Flagship refined its key focal research areas and identified the key outputs to be delivered to end users to achieve maximum impact. The roadmap represents the consolidation of the impact statements and therefore direct comparison against last year's roadmap is not possible.

**Flagship goal:** To provide Australia with the knowledge and tools to protect coastal and ocean environments, increase their value to society and create a net economic benefit of \$3 billion per annum.

### CSIRO assists in maritime safety

The Wealth from Oceans Flagship is working with industry and government to ensure that extracting and transporting marine energy resources is done safely. Part of delivering safety involves improving industry's and government's response to marine emergencies. CSIRO's science and technologies have been proven in response to the Gulf of Mexico oil spill and were called upon on 8 January 2012, when the Panamanian-flagged *MV Tycoon* broke its mooring in the rough seas of Flying Fish Cove, Christmas Island and foundered against the cliff edge of the harbour. The vessel had approximately 102 tonnes of intermediate fuel oil, 11 tonnes of lubricants, 32 tonnes of diesel oil and 260 tonnes of bagged phosphate dust on board. Fortunately, minimal oil or phosphate spilled into the sea, avoiding catastrophic impact on Christmas Island's unique ecosystems.

As part of an emergency response team, the Australian Maritime Safety Authority (AMSA) asked for CSIRO's support in developing a marine impacts monitoring program, which included an informal peer review of the draft monitoring plan.

CSIRO scientists identified biodiversity likely to be threatened by the spill and, drawing upon work conducted in 2009 with Geoscience Australia, were able to define the conservation values for the area and assist in designing environmental monitoring strategies.

The *MV Tycoon* foundering highlighted the usefulness of an Australian Atlas of Marine Information, which would include information about biodiversity to governance arrangements. A key component of the Flagship's work is to improve marine environmental planning and management in Australia. As a result of this event, CSIRO and AMSA are now investigating a more formal arrangement for CSIRO to assist with any potential future environmental incidents.



CSIRO's expertise helped to identify conservation resources in the area that were likely to be threatened by the foundered *MV Tycoon*. Image: Kelana Arshad

# Program 2 – Core Research and Services

## Objectives and deliverables

CSIRO's Core Research and Services Program covers a range of non-Flagship research portfolios and capabilities which target improvements in industry, the environment and community wellbeing through the provision of advice, information and solutions.

In 2011–12, CSIRO's five Research Groups delivered new and improved technologies, management systems, intermediate and final products, catalyst services for business, advice relevant to policy development, and new knowledge and skills through a range

of portfolios. These portfolios accounted for 43.2 per cent of total resources. The Research Groups are also responsible for the development and nurturing of research capability, ensuring the excellence of CSIRO's science and its relevance to current emerging needs.

## Core Research and Services – Program performance

The performance of CSIRO's Core Research and Services Program is assessed through four key performance indicators. Table 2.8 provides a summary of progress with more detailed analysis and trend data following the Table.

**TABLE 2.8: PERFORMANCE INDICATORS FOR PROGRAM 2 – CORE RESEARCH AND SERVICES**

KEY PERFORMANCE INDICATOR	TARGET	PERFORMANCE
Demonstrated adoption and impact of core research outputs.	Growing economic, social, environmental and intangible benefits	Recent achievements from each of the five Research Groups are reported on pages 46–55.
The number of refereed Core Research publications <sup>1</sup> .	Maintain or increase	In 2011, CSIRO maintained a high output of refereed core research publications, with journal articles increasing by 7.6 per cent from the previous year (more on pages 40–43).
Customer Satisfaction.	Maintained	A customer satisfaction survey trial was conducted in 2011–12. A baseline against which we will track performance will be established in 2012–13 (more on page 20).
Science excellence in CSIRO research capabilities as assessed through a rolling program of rigorous peer review.	Maintain or increase	2012 saw the second round of Divisional Science Assessment Reviews completed. The aggregated results showed the impact of CSIRO's science excellence was maintained, with ratings by the panels of peers for the majority of themes being strong or favourable (more on pages 44–45).

<sup>1</sup> Core Research Publications include all publications produced by CSIRO including Flagship refereed publications.

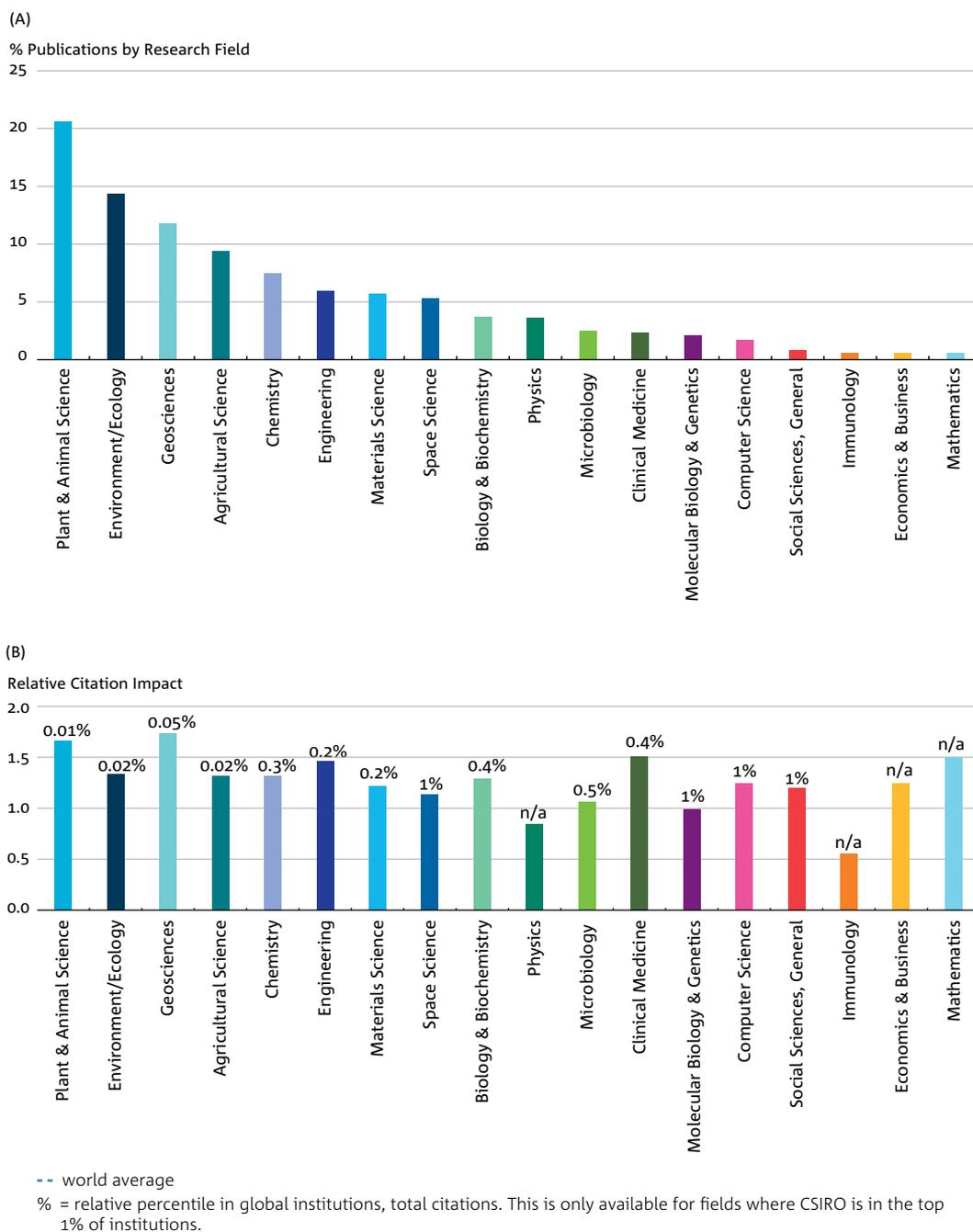
## Refereed Core Research journal publications

In the 2011 calendar year, CSIRO produced 5.6 per cent of Australia's research publications, with Australia representing 3.1 per cent of the global research publications. In addition, CSIRO ranks in the top 0.1 per cent of global institutions in Plant and Animal Sciences; Agricultural Sciences; Environment and Ecology; and Geosciences (based on total citations).

Approximately 60 per cent of all CSIRO's publications are produced in its four highest ranking fields, see Figure 2.7 (A). The remaining ten fields in which CSIRO ranks in the top 1 per cent are shown in Figure 2.7 (B). Figure 2.7 (B) also includes research fields in which CSIRO is not in the top 1 per cent globally.

Citation impact is measured as CSIRO's average citation rate relative to the world average for each field.

**FIGURE 2.7: CSIRO PUBLICATION (A) OUTPUT AND (B) CITATION IMPACT BY RESEARCH FIELD, 2002–11.<sup>9</sup>**

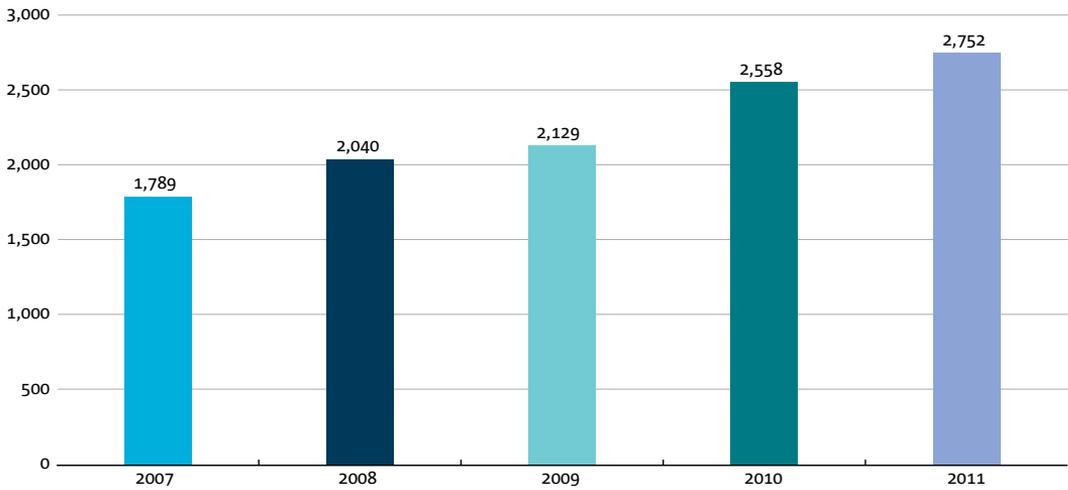


These results are consistent with historical and collaboration trends. Figure 2.8 shows the number of journal articles produced by CSIRO, which has been trending upwards over the last five years. This year this has been supported by

the total number of articles and reviews in the journal *Nature* and its affiliates, *Science* and the *Proceedings of the National Academy of Sciences of the USA*, and increased from 24 in 2010 to 34 in 2011.

<sup>9</sup> ISI Essential Science Indicators and InCites, Thomson-Reuters

**FIGURE 2.8: CSIRO JOURNAL ARTICLE PUBLICATIONS<sup>10</sup>**

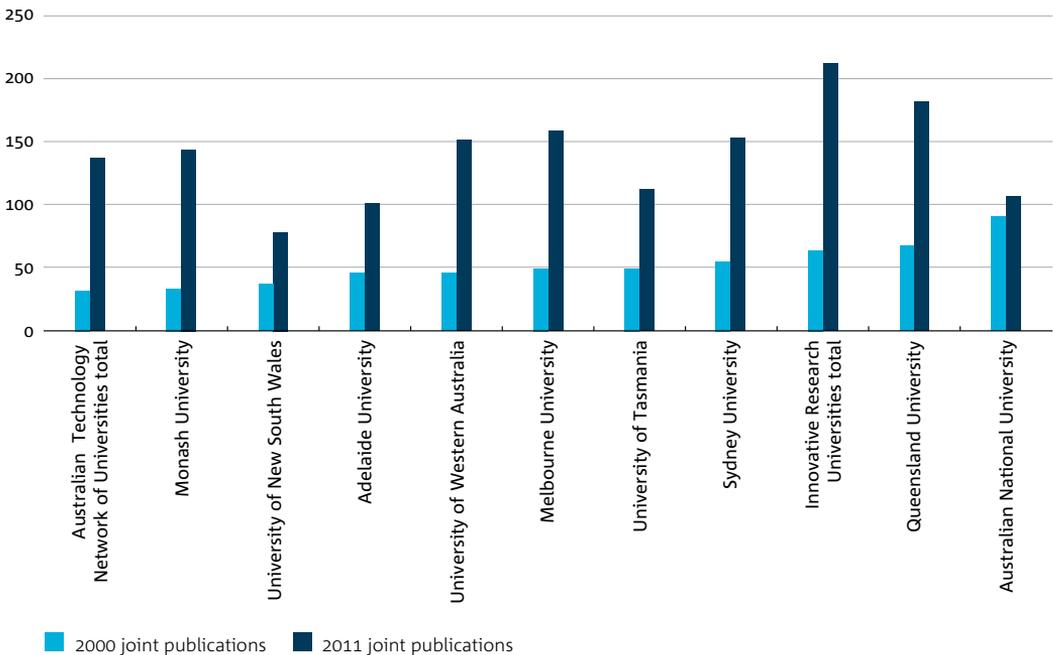


In 2011, CSIRO produced 80 per cent of its publications in collaboration with authors from other institutions. Forty-eight per cent were produced with international co-authors and 54 per cent with authors from other Australian institutions.

Figure 2.9 shows that CSIRO’s collaboration with Australian universities has increased substantially

since 2000 (as measured by joint publications). CSIRO continues to collaborate with the Group of Eight universities, with universities in the Australian Technology Network of Universities (31 joint publications in 2000 to 137 in 2011) and with those in the Innovative Research Universities (64 joint publications in 2000 to 213 in 2011), which has also increased.

**FIGURE 2.9: JOINT RESEARCH PUBLICATIONS WITH AUSTRALIAN UNIVERSITIES<sup>11</sup>**



<sup>10</sup> Source: Web of Science, Thomson-Reuters

<sup>11</sup> Source: Web of Science, Thomson-Reuters

Internationally, CSIRO has also significantly increased the rate of collaboration with organisations overseas (as measured by joint publications), see Figure 2.10. Joint publications with institutes in China have increased from 23 in 2000 to almost 200 in 2011. Over the same period joint publications with USA institutes have almost doubled.

**FIGURE 2.10: JOINT RESEARCH PUBLICATIONS WITH TOP TEN COUNTRIES<sup>12</sup>**

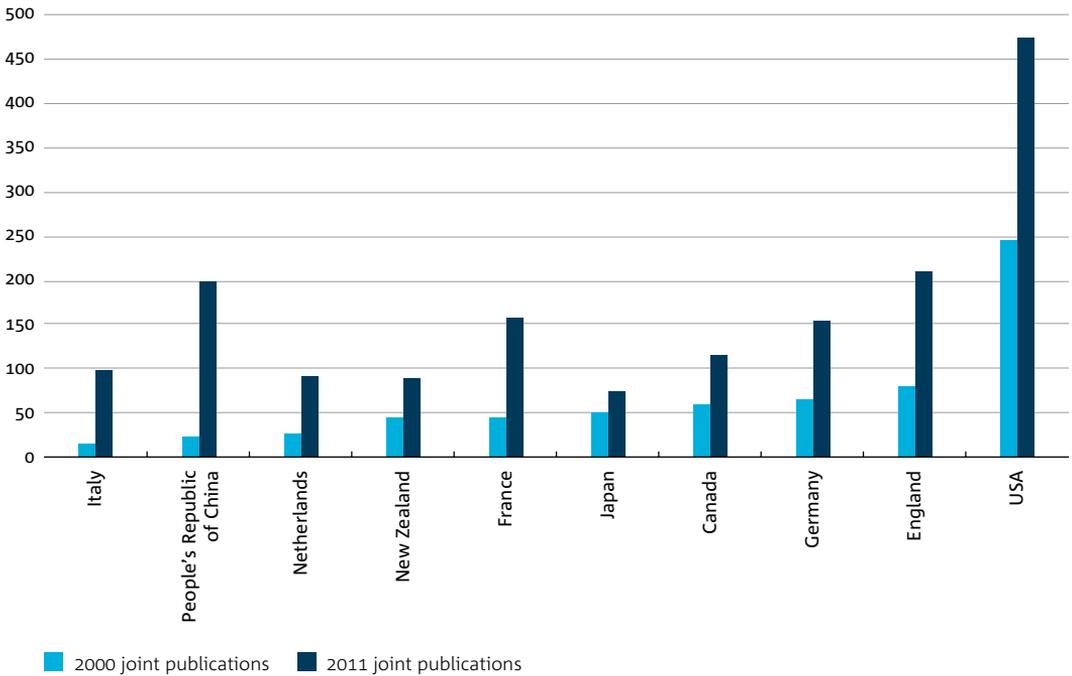
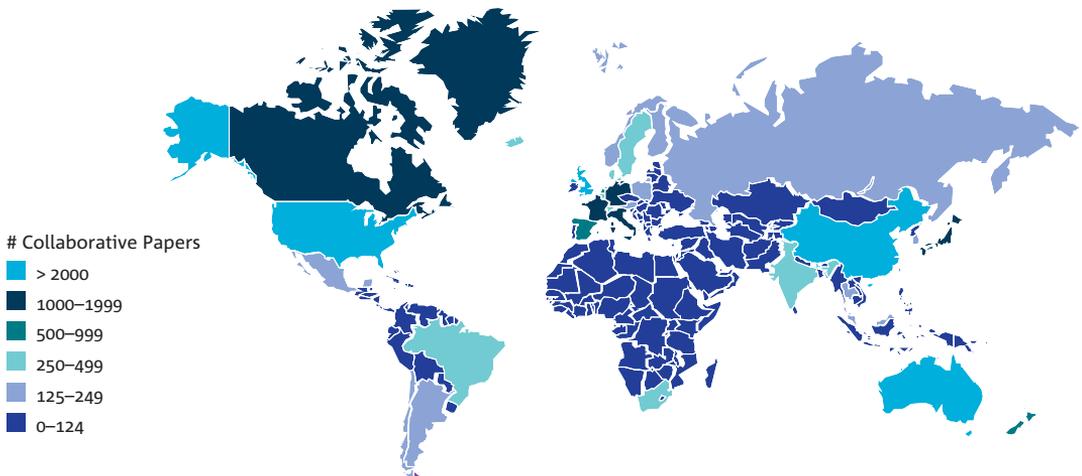


Figure 2.11 shows the potential impact of our science capability through collaboration with international authors. The top ten countries with which CSIRO co-publishes with in descending order are: USA, United Kingdom, China, France, Germany, Italy, Japan, Canada, New Zealand and the Netherlands.

**FIGURE 2.11: CSIRO JOINT PUBLICATIONS WITH INTERNATIONAL AUTHORS, 2002-11<sup>13</sup>**



12 Source: Web of Science, Thomson-Reuters

13 Source: Web of Science, Thomson-Reuters

## Research capability and scientific excellence – Science assessment reviews

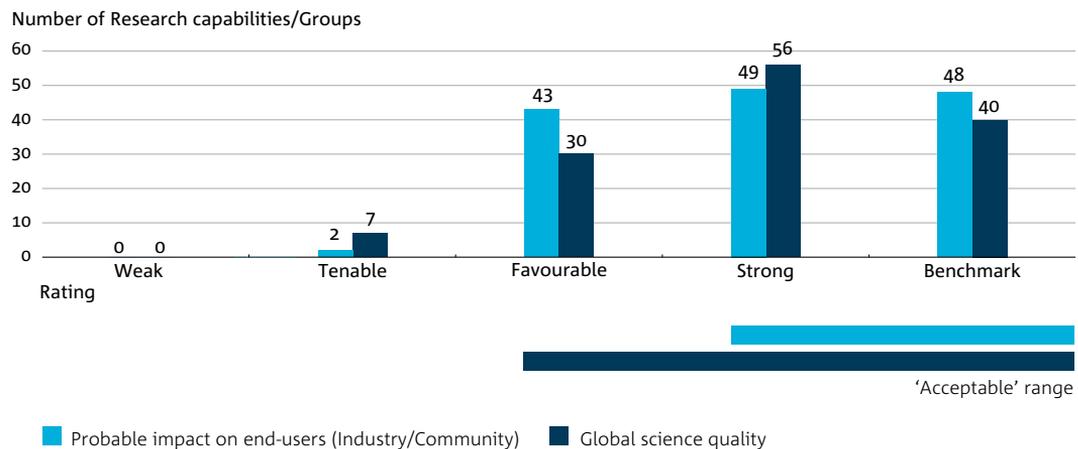
A key element in CSIRO’s success has been its development and continued maintenance of high-quality scientific capability (including world-class researchers, research infrastructure and collaborative relationships). Since 2005, CSIRO has maintained this high standard in research capability through a cyclical (three to five year) review program of independent robust and rigorous Divisional reviews.

The assessments are led by a panel of independent scientific experts (usually three from overseas and two from Australia) whose

knowledge and skills provide an appraisal of the capability performance of a Division, as well as suggestions as to how the performance of research teams can be increased.

This financial year concluded the second cycle of the review program, including an assessment of 141 Research Groups/capabilities in total. The results from this cycle of reviews can be seen in Figure 2.12. Ratings for the Research Groups / capabilities are against two key dimensions of the review; community / industry and international research capability. Table 2.9 shows the independent review panel’s ratings (according to a five point scale) for probable impact on end-users and quality of science.

**FIGURE 2.12: AGGREGATE RATINGS FOR CYCLE TWO SCIENCE ASSESSMENT REVIEWS COMPLETED AS AT 30 JUNE 2012**



**TABLE 2.9: RATINGS FOR TWO DIMENSIONS PROVIDED BY INDEPENDENT REVIEW PANELS<sup>14</sup>**

	COMMUNITY / INDUSTRY (PROBABLE IMPACT ON END-USERS)	INTERNATIONAL RESEARCH (QUALITY OF THE SCIENCE)
Benchmark	The research results are used to set the pace and direction of commercial, environmental, community or policy development – recognised in industry or the community for this.	Sustained scientific leader – well recognised in the international research community.
Strong	The research results enable commercial, environmental, community or policy development that distinguishes user organisations from peers or competitors.	Able to set and sustain new scientific/ technical directions within the international research community.
Favourable	The research results enable commercial, environmental, community or policy development that organisations use to improve their position relative to peer or competitors.	Able to maintain a good position within the international research community; not a scientific leader except in niches outside mainstream areas.

<sup>14</sup> Divisional Review Assessment Criteria.

	COMMUNITY / INDUSTRY (PROBABLE IMPACT ON END-USERS)	INTERNATIONAL RESEARCH (QUALITY OF THE SCIENCE)
Tenable	The research results are used by organisations for commercial, environmental, community or policy development that maintains, but does not improve, their position relative to peers or competitors.	Not able to set or sustain independent scientific/technical directions – a sense of being continually a follower.
Weak	The research results are not able to be used by organisations to even maintain their position relative to peers or competitors.	Declining quality of scientific/technical output compared with other research groups. Often a short-term reactionary focus.

As demonstrated in Figure 2.12, the aggregate results from the second round of reviews show that the proportion of scientific areas of work within the Divisions were assessed by the panels as having a research impact rated as ‘favourable’ or better, was 95 per cent. The proportion of research capabilities assessed by the panels as having industry / community impact of ‘strong’ or better was 68 per cent. The proportion of research capabilities assessed as at an ‘acceptable’ range in both aspects (that is,

a benchmark, strong or favourable assessment for research impact and benchmark or strong in industry / community impact) was 67.4 per cent.



# Energy<sup>1</sup>

## Analysis of performance

### THE CHALLENGES

Powering the future is one of the greatest environmental, economic and social challenges we have to resolve in the early decades of the 21st century. Australia has one of the world's largest carbon footprints per person, with nearly 70 per cent due to energy emissions. There is also heightened community concern about sustainable resource extraction. These concerns need to be balanced against the fact that Australia is a large energy exporter, which contributes significantly to the region's (and Australia's) long-term economic prosperity and energy security.

### OUR RESPONSE

CSIRO is tackling these challenges with our energy research portfolio directed at the delivery of secure and affordable low-emissions energy. Our key focus is to help accelerate large-scale emissions cuts, while ensuring a smooth transition to a new energy future. To achieve this, we are working with industry, governments, the community and our research partners to demonstrate new lower emissions energy technologies. Together with our partners, CSIRO is involved in pilot and demonstration-scale activities, both here and overseas, including carbon capture and storage, concentrated solar thermal energy, photovoltaics, geothermal, smart grids, energy storage, biofuels and enhanced coal bed methane.

### OUR IMPACT

During the financial year, CSIRO's report on commercial building wireless monitoring and measurement was included in the Council of Australian Governments reference book on wireless metering (associated with the National Strategy on Energy Efficiency and the heating, ventilation, and air conditioning (HVAC) High Efficiency Systems Strategy). This reference

book will help the HVAC industry (building owners and service providers) to recognise that wireless metering is a potentially low-cost and effective way of metering energy consumption in buildings. More detailed metering will also help building owners to build the case for energy efficiency upgrades and to manage their energy consumption.

In November 2011, CSIRO, working with the Bureau of Meteorology, the Australian Department of Climate Change and Energy Efficiency, and AusAID, carried out the most comprehensive scientific analysis to date of climate change in the Pacific region. Prior to the release of this research there had only been limited country-specific climate information available. This report addresses a crucial need for reliable information to help Pacific countries effectively plan for climate change.

Additionally, the Energy Group, working with the Western Australian Geothermal Centre of Excellence, a joint venture between CSIRO, the University of Western Australia and Curtin University of Technology, developed a 3D geological model of the Perth Basin, the first of its kind. The model helps to accurately locate geothermal systems which will greatly reduce the cost and risk of exploration. The technique can be applied to other basins around the world to identify and assess resources such as oil, gas, groundwater and carbon capture and storage potential.

This year the Census of Marine Life scientific committee was awarded the International Cosmos Prize from the Expo90 committee for this unprecedented international project. The Census is the world's first comprehensive stocktake of marine life in the global ocean.

<sup>1</sup> See Appendix 5, page 180 for the structure of each Research Group.

**Research group aim:** To develop and apply leading-edge energy research that reduces greenhouse gas emissions; ensures energy supply; maximises Australia's wealth from its energy resources; and derives increased, sustainable benefits from Australia's marine resources while ensuring conservation of our marine biodiversity and coastal habitats and settlements.



**The post carbon capture pilot plant at the Tarong Power Plant, Queensland.**

## Reducing greenhouse emissions

Reducing greenhouse gas emissions from fossil fuels is a key challenge for many nations, including Australia. Over the last decade, carbon dioxide capture and storage (CCS) has emerged as an effective way to reduce emissions from fossil energy power plants. CSIRO has been working closely with industry and government in Australia and overseas, to complete and report on research related to the post-combustion capture and storage of carbon dioxide.

In March 2012, CSIRO released its findings on carbon dioxide capture. The results showed that the technology is viable, applicable and technically available. The research comprised the establishment of post-combustion capture (PCC) pilot plants at two power stations in Australia, extensive laboratory studies on carbon dioxide (CO<sub>2</sub>) absorbents and the modelling of a range of processes and designs for PCC plants. The research revealed that more than 85 per cent of carbon dioxide was captured from a power station's flue gases, along with other gases such as sulphur dioxide.

CSIRO scientists working in the Cooperative Research Centre for Greenhouse Gas Technologies (CO<sub>2</sub>CRC) have shown that the underground storage of CO<sub>2</sub>, the final step in the CCS chain, is a technically and environmentally safe way to make deep cuts into Australia's greenhouse gas emissions. The CO<sub>2</sub>CRC Otway Project demonstrated that depleted gas fields can be used to store significant amounts of carbon dioxide. Since 2008, over 65,000 tonnes of CO<sub>2</sub>-rich gas has been injected two kilometres underground in a depleted natural gas reservoir in the Otway Basin located about 200 kilometres west of Melbourne, Victoria.



# Environment<sup>1</sup>

## Analysis of performance

The Environment Group delivered on its goals in 2011–12 and met its financial targets despite some challenging external influences. Positive relationships with state and federal agencies deepened, as has the Group's role as a Trusted Advisor on water, marine, climate and biodiversity issues. Our international linkages are also growing and strengthening – illustrated by the implementation of a new Memorandum of Understanding with the US National Oceanic and Atmospheric Administration, our participation in the Belmont Forum on Global Change and the Intergovernmental Platform on Biodiversity and Ecosystem Service, as well as growing collaborations in China and India.

### DELIVERING CLIMATE INFORMATION

Development of the Australian Community Climate and Earth System Simulator (ACCESS) – the next generation platform for Australia's weather forecasting, climate projection, and earth system simulation capability – continued in collaboration with the Bureau of Meteorology. ACCESS has been delivering Australia's weather forecasts for more than two years and is being adopted by several Australian institutions as the standard platform for earth system simulation and climate change projections. CSIRO has again delivered the most up-to-date assessments for Australian greenhouse gas concentrations in the atmosphere and the analyses of humankind's contribution to them.

### INDUSTRY PARTNERSHIP

The Environment Group, as a foundation partner with Australia Pacific LNG, cofounded the Gas Industry Environmental and Social Research Alliance. The Alliance is helping address environmental and social issues that relate to Australian coal seam gas industry developments.

### BIODIVERSITY

During the financial year, the Group expanded its biodiversity research through *The Atlas of Living Australia*, which added its 30 millionth species on record. The Group also renewed a joint development agreement around the commercialisation of bee silks with its European partner. Market development around bioremediation enzymes progressed rapidly and a preferred commercial partner was identified in China.

In a global first, CSIRO's Environment Group published guidelines for developing management plans in Indigenous Protected Areas (IPAs). This involved collaboration with managers from 50 declared IPAs across Australia and was delivered through a partnership with the federal government.

### NEW RESEARCH VESSEL

This financial year also marks significant milestones in the commissioning of the *RV Investigator* – Australia's purpose built Marine National Facility. When operational, the 96-metre ship will accommodate 40 scientists and cover 10,000 nautical miles in each voyage, significantly boosting science capability in the region.

### COMMUNICATION

The CSIRO Environment Communications Strategy continues to be well executed with multiple authoritative publications in climate and water domains made available to the Australian public, including the first two books in the series *Science and Solutions for Australia – Climate Change* and *Water*, as well as the second *State of the Climate* report.

<sup>1</sup> See Appendix 5, page 180 for the structure of each Research Group.

**Research group aim:** A sustainable Australia addressing global challenges, in which CSIRO's Environmental research and development role is pivotal and acclaimed<sup>2</sup>.

### State of the Climate 2012

In March 2012, CSIRO and the Bureau of Meteorology released the *State of the Climate 2012* report – an updated summary of Australia's long-term climate trends. The report noted that Australia's land and oceans have continued to warm in response to rising carbon dioxide emissions from the burning of fossil fuels.

The latest report, which is updated and released every two years, stated that much of Australia has transitioned from drought to floods since the release of the *State of the Climate 2010* report. This transition has occurred in conjunction with steadily increasing air and ocean temperatures and rising sea levels.

The report demonstrates that global warming continues and that human activity is mainly responsible, noting that the fundamental physical and chemical processes leading to climate change are well understood.

*State of the Climate 2012* confirms that, since the 1950s, in Australia, each decade has been warmer than the previous decade, with an increase in the number of warm nights, and an increase in monthly maximum temperatures being broken. In 2011, carbon dioxide concentration in the atmosphere had risen to around 390 parts per million, a level unprecedented in the past 800,000 years. In the past decade it has risen more than three per cent per year, which is projected to contribute significantly to global warming.

CSIRO and the Bureau of Meteorology will continue to provide observations, projections, research, and analysis so that Australia's responses to the challenges of a changing climate are underpinned by robust scientific evidence of the highest quality.

The *State of the Climate 2012* report can be found at: [www.csiro.au/State-of-the-Climate-2012](http://www.csiro.au/State-of-the-Climate-2012)



**A new report released by CSIRO and the Bureau of Meteorology reported that climate change is continuing and that human activities are mainly responsible.**

2 The Environment Group aim has been updated to better reflect the Group's objectives under CSIRO's wider strategic plan.

# Food, Health and Life Science Industries<sup>1</sup>



## Analysis of Performance

In 2011–12, the Food, Health and Life Science Industries (FHLSI) Group continued to deliver world-class expertise to four vital sectors of the Australian economy covering food security, health, biosecurity and new life science industries.

### SUSTAINABLE FOOD SECURITY

Increasing agricultural productivity sustainably is a key fundamental need for both Australia and the world as the population expands towards an estimated nine billion by 2050.

In 2012 CSIRO's expertise in agribusiness helped a farmer produce record wheat yields in Queensland, using our innovative crop management system. The new technique combines detailed advice on managing sowing time, seeding rate, variety selection, timing of fertiliser application and control of leaf diseases (more on page 35).

### HUMAN DISEASE PREVENTION

In the health sector, CSIRO and its partner, Clinical Genomics, have identified genes that show changes in the blood of people with bowel cancer. A world first blood based test for bowel cancer using these discoveries is under development and currently being trialled with patients from Australia, the US and Europe (more on page 33).

In addition, CSIRO conducted new research showing it is the *type* of dietary fibre, not just the amount, which leads to changes in the bowel which protects against this disease. The study highlighted the beneficial role of resistant starch in reducing the incidence of bowel cancer, which affects more than 14,000 Australians each year.

In May 2012, CSIRO launched the *CSIRO Total Wellbeing Diet Fast and Fresh Recipes* book. The new book provides further meal options for the Total Wellbeing Diet, which has already helped thousands of Australians achieve sustainable weight loss with improved health consequences, particularly in chronic disease prevention.

### BIOSECURITY

In November 2011, the world's most advanced bio-secure laboratory was opened at CSIRO's Australian Animal Health Laboratory in Geelong, Victoria. The new \$11.5 million laboratory is a maximum 'level 4' biosecurity facility, providing important new research capability to help deal with dangerous pests and pathogens.

A new Biosecurity Flagship within CSIRO commenced operation on 1 July 2012. The Flagship will play a vital role protecting the health of our farming sector, environment and people and boost Australia's long-term biosecurity research capability.

### NEW INDUSTRY OPPORTUNITIES

CSIRO is continually, improving the competitiveness of existing industries and developing new life science technologies, sustainable sources of food and new bio-materials. Our expertise in aquafeed technology has seen prawn growth rates increase by 20 per cent in commercial farm trials and our selective breeding programs have seen a 30 per cent increase in the number of aquaculture ponds stocking CSIRO's elite prawns (more on page 26).

The Group's expertise in plant oil research is leading to new opportunities for Australian farmers. A breakthrough development in safflower oil is an important step in providing a viable and renewable resource for the petrochemical industry (more on page 51).

### BUILDING SCIENCE CAPABILITY

On 1 July 2012, CSIRO's Divisions of Food and Nutritional Sciences and Livestock Industries amalgamated to become the Division of Animal, Food and Health Sciences and will maintain and develop science excellence in plant, animal and human science capability areas.

The Group is leading the establishment of a precinct which will focus on natural sciences at Black Mountain, Canberra, in line with CSIRO's 2011–15 Strategy. The precinct will be a global leader in plant sciences, focusing on agricultural and environmental genomics, and will attract the world's best researchers and key industry collaborators.

<sup>1</sup> See Appendix 5, page 180 for the structure of each Research Group.

**Research group aim:** To deliver sustainable productivity growth and value to food and fibre production in support of the economy, the environment and the health of Australians. We will do this through scientific excellence in the biological and food sciences and their application to creating profound impact across the agricultural value chain, health, biosecurity and industry<sup>2</sup>.

### New safflower seed oil for industrial use

Special new safflower plants containing the world's highest levels of valuable oleic acid are closer to becoming a reality for Australian grain growers due to research at CSIRO. Experimental safflower plants have produced safflower seed oil that contains more than 90 per cent of this valuable fatty acid, the highest level of purity of an individual fatty acid present in any currently available plant oils.

Called super-high oleic (SHO) safflower, this new development is the important first step towards providing environmental and economic benefits to Australia. Should the SHO safflower be commercialised, then Australian grain growers will have a unique opportunity to produce and supply renewable, sustainable plant oils for industrial use, and these oils could one day replace petrochemicals in industrial products ranging from fuel and lubricants to specialty chemicals and plastics. Petroleum is a finite resource and the world is searching for replacements. Renewable plant oils will have a huge, positive impact reducing our reliance on petroleum-based products.

The research team used CSIRO's gene silencing technology to boost levels of desirable oleic acid by switching off its conversion to other unwanted fatty acids in the safflower oil.

This breakthrough SHO safflower oil is a versatile and valuable industrial raw material that combines high purity for industrial chemical production with tremendous stability for direct use in industrial lubricants and fluids. Safflower is an ideal crop for Australian biofactories as it is a very hardy crop that does well in warm seasonal conditions and should cope well with the expected stresses of climate change.

SHO safflower was developed by the Crop Biofactories Initiative, a strategic research and product development partnership between CSIRO and the Grains Research and Development Corporation.



**Super-high oleic safflower seed, a renewable plant oil, will have a positive impact in reducing our reliance on petrochemicals.**

2 The FHLSI Group aim has been updated to better reflect the Group's objectives under CSIRO's wider strategic plan.

# Information Sciences Group<sup>1</sup>

## Analysis of performance

### FASTER BROADBAND

During 2011–12, the Group opened up opportunities for broadband technologies in rural and regional Australia. Wireless backhaul systems typically provide communication links between phone towers, townships and businesses.

In February 2012, CSIRO's Ngarra technology achieved the world's fastest wireless backhaul data rates over distances up to 50 kilometres, at least 20 times faster than existing technology. The technology could enable people living in remote areas to receive high performance broadband services.

### SQUARE KILOMETRE ARRAY

In May 2012, the Square Kilometre Array (SKA) Organisation announced that the \$2.5 billion Square Kilometre Array radio telescope would be deployed in Australia, New Zealand and South Africa. The SKA will be the world's largest and most sensitive radio telescope and will help address unanswered questions about our universe, including how the first stars and galaxies were formed and the role of magnetism in the cosmos. The SKA telescope infrastructure will be located 350 kilometres north-east of Geraldton in Western Australia. The site already hosts CSIRO's Australian SKA Pathfinder (ASKAP) radio telescope. Construction of the SKA Phase 1 is expected to start in 2016 and preliminary science operations are to take place by 2020.

### NEW NATIONAL RESEARCH FLAGSHIP

The Group is also focusing its research efforts in services-related domains including health, the environment, infrastructure, finance and biotechnology, to identify how smart information can add value to these industries. In July 2012, a new National Research Flagship focusing on services and the digital economy commenced, maximising the opportunities presented by the national broadband infrastructure.

### DEMONSTRATING OUR RESEARCH

Our capabilities in mathematics, informatics and statistics continue to be applied to national and global challenges. To help prepare for natural and man-made disasters, our researchers have modelled the effects of a catastrophic failure of the massive Geheyuan Dam in China's Hubei province. Scientists have simulated the impact on the surrounding region and its infrastructure if the dam suddenly released its 3.12 billion cubic metres of water. The work is helping authorities prepare for disasters and could also help Australia plan for extreme weather events.

The Group continues to lead development of e-research capabilities, critical for carrying out research requiring extremely large data collections, high-end super computing resources, and global collaborations. The impact of this high-end e-research capability was demonstrated in April 2012, when CSIRO scientists set a new record of more than 1.1 million tasks run at night across 3,000 idle desktops. Using this infrastructure, plant researchers were able to submit 400,000 tasks (4 million crop growth simulations) within two days, equivalent to 16 years work for a single personal computer. Developments such as this help speed up science discovery so that new knowledge can be adopted more quickly and help improve the way we work and live. In addition, in November 2011, CSIRO's general processing unit cluster supercomputer was ranked 212 in the Top500 list of the world's fastest supercomputers and 38th on the Green500 list, making it Australia's greenest supercomputer.

<sup>1</sup> See Appendix 5, page 180 for the structure of each Research Group.

**Research group aim:** To work with partners to solve national challenges, drive the productivity of Australian industries, and deliver public good outcomes through the innovative application of mathematical, statistical, information and communication sciences and technologies, and to build Australia's role in developing the next generation of space sciences.

### The freedom of wireless

CSIRO invented and patented its wireless networking technology in the 1990s – a technology that has given us the freedom to work wirelessly in our homes, classrooms and offices, using devices such as laptops and smart phones.

The technology is estimated to be in more than three billion devices worldwide. It is used in offices, public buildings, homes and coffee shops – often called 'Wi-Fi hotspots' – allowing people to move around within the local coverage area and still be connected to the internet.

The invention came out of CSIRO's pioneering work in radioastronomy. That work involved complex mathematics known as 'fast Fourier transforms' as well as detailed knowledge about radio waves and their behaviour in different environments. Indoor environments are particularly difficult for the rapid exchange of large amounts of data using radio waves. CSIRO solved the main problem of wireless networking in a unique way at a time when many of the major communications companies around the world were trying, with less success, to solve the same problem.

CSIRO now has licence agreements with more than 20 companies and has received more than \$430 million in revenue from this technology. In April 2012, the Minister for Tertiary Education, Skills, Science and Research, Senator the Hon Chris Evans, announced that a major part of CSIRO's most recent US litigation involving its wireless local area network (WLAN) patent had been settled prior to trial. The WLAN team is credited with creating a technology that will be in more than five billion devices worldwide by the time the patent expires at the end of 2013.

CSIRO inventors Dr John O'Sullivan, Dr Terry Percival, Mr Diet Ostry, Mr Graham Daniels and Mr John Deane won the 2012 European Inventor Awards in the 'non-European countries' category for CSIRO's patented WLAN technology. The awards are presented by the European Patent Office and this is the first time an Australian team has won.



CSIRO's WLAN technology is estimated to be in more than three billion devices worldwide.  
Image: iStockPhoto



# Manufacturing, Materials and Minerals Group<sup>1</sup>

## Analysis of performance

The Manufacturing, Materials and Minerals (MMM) Group works in partnership with local and multinational organisations to deliver technologies, products and processes for Australia's sustainable competitive advantage. The Group works closely with companies and agencies in aerospace, automotive, renewable energy, defence, textiles, building infrastructure, health, chemicals, plastics, packaging, mineral exploration, mining, mineral processing and metals production.

In 2011–12, the Group forged new national and international relationships and continues to foster its existing relationships with industry, research providers and governments. In addition, the Group provided expert advice to policy makers and industry groups through forums such as the Prime Minister's Taskforce on Manufacturing and Vision 2040, which provides a vision for Australia's minerals future.

### ALLIANCES

In December 2011, the CSIRO-Chile International Centre of Excellence in Mining and Mineral Processing was established. The Centre, with nodes in Santiago and Antofagasta, involves CSIRO working with the Chilean Government, universities and industry on challenges facing the minerals industry in both countries. The overarching aim is to increase the productivity and reduce the environmental impact of the industry by focusing on the issues of processing lower-grade ores, delivering safer and more efficient mining, clean processing and creating value-added mineral products.

The Group continued to develop its alliances with companies such as Boeing, General Electric and Orica, along with assisting more than 700 Australian small-to-medium enterprises (SMEs).

### BUILDING AUSTRALIA'S SMEs

In addition to providing a testing and consulting service and delivering research and development projects for many SMEs, the MMM Group works closely with Enterprise Connect, the Australian

Government organisation which helps connect businesses with the knowledge, tools and expertise necessary to improve productivity and increase competitiveness. The Group continues to engage with SMEs through the Enterprise Connect 'Researcher-in-Business' program, and provides CSIRO researchers the opportunity to spend time in, and to assist with, internal research and development and provide valuable scientific expertise.

### GROWING THROUGH COLLABORATION

Australia has the opportunity to build a number of research precincts of global standing and scale. We are joining with others in a shared vision to build vibrant sites in places where there is already a depth of industry and research infrastructure. We will create centres with critical mass by attracting the world's best minds. The Group is working with partners to develop concepts and plans for the Australian Manufacturing and Materials Innovation Precinct in Clayton, Victoria, the Human Life Sciences Precinct in Parkville, Victoria, and the Mineral Resources Research Precinct, encompassing the Perth suburbs of Kensington and Waterford.

This year has seen the launch of two new clusters. The CSIRO Organic Geochemistry of Mineral Systems Cluster, in Perth, will address future sustainability issues facing the minerals industry in Australia. The Transparent Electrodes for Plastic Electronics Research Cluster, in Brisbane is looking at producing cheap, flexible optoelectronic devices such as displays and lighting based on organic light-emitting diodes, solar cells, plastic electronics and sensors – technologies for use in products ranging from plastic solar cells to flexible televisions.

The Group continues to progress major co-locations with universities and industry, including the New Horizons initiative with Monash University at Clayton. This initiative aims to transform manufacturing in areas such as polymers, biomedicine, transport and aerospace, and the Australian Future Fibre Research and Innovations Centre with Deakin University in Geelong.

<sup>1</sup> See Appendix 5, page 180 for the structure of each Research Group.

**Research group aim:** To help grow Australia's wealth by developing improved commercial products and processes, fostering increased productivity, and supporting business and job creation in an environmentally and socially responsible manner.

### First RAFT-based product released

Lubrizol Corporation in the USA has created advanced highly-viscose polymers, known as Asteric™ Viscosity Modifiers, using CSIRO's RAFT (Reversible Addition Fragmentation chain Transfer) technology. This first RAFT-based product was launched in August 2011 at the American Chemical Society Conference and is now commercially available. Lubrizol developed Asteric™ using RAFT to create an innovative star shaped polymer for use in a variety of passenger vehicle transmission and mobile equipment applications worldwide. The star shape dramatically improves the viscosity performance of Asteric™.

RAFT has received significant global interest and, working with our partner DuPont, we are licensing the technology across a number of markets. Other applications will include better drug delivery systems, next generation cosmetics, better performing biomedical materials, new agrochemicals, next generation solar cells and improved industrial chemicals.

The RAFT research was a key achievement that led to the Prime Minister's Science Prize for 2011 being awarded to CSIRO's Dr Ezio Rizzardo and Professor David Solomon from the University of Melbourne (formerly CSIRO). Dr Rizzardo and Professor Solomon were recognised for their long and distinguished research careers that led to a revolution in polymer science, profoundly impacting the level of control we have over polymer structure and function (see page 73 for more information on awards and honours). Dr Rizzardo is the key inventor of the RAFT technology and continues to lead CSIRO's RAFT research.



Prime Minister's Science Prize winners, Professor David Solomon (left) and Dr Ezio Rizzardo (right) with Prime Minister Julia Gillard. Image: Department of Industry, Innovation, Science, Research and Tertiary Education

# Program 3 – Science Outreach: Education and Scientific Publishing

## Science Outreach – objectives and deliverables

Communicating scientific research helps raise the profile of science and CSIRO within the community. CSIRO conducts a range of science education programs for school students, their teachers and the public. We host the CSIRO Discovery Centre in Canberra and operate major visitor centres at the Parkes Observatory in New South Wales and the Canberra Deep Space Communication Complex.

CSIRO also operates **CSIRO PUBLISHING** as an independent science and technology publisher with a global reputation for quality products and services covering a wide range of scientific disciplines, including agriculture, chemistry, the plant and animal sciences, and environmental management. **CSIRO PUBLISHING** operates within CSIRO on a commercial basis on behalf of authors and customers in Australia and overseas.

CSIRO also runs a postgraduate scholarship program which provides opportunities in science and engineering for outstanding graduates who enrol at Australian tertiary institutions as full-time postgraduate students for research leading to the award of a PhD. PhD students at CSIRO are co-supervised by a university, allowing students to maintain and develop their university connections while being exposed to research in a working environment, see Table 2.10. The number of students fluctuates, with uneven intakes each year, and a reduction in student numbers is often seen when a cohort moves through the program.

Some CSIRO Divisions have collaborative arrangements with universities to foster PhD studies in particular areas – for example, CSIRO Marine and Atmospheric Research and the University of Tasmania run a joint PhD Program.

**TABLE 2.10: SCIENCE OUTREACH – CSIRO’S POSTGRADUATE STUDENTS**

	2007–08	2008–09	2009–10	2010–11	2011–12
<b>Sponsored postgraduates<sup>(a)</sup></b>					
PhD	241	338	375	333	291
Masters	18	9	13	24	20
Honours	13	17	25	19	17
<b>Total</b>	<b>272</b>	<b>364</b>	<b>413</b>	<b>376</b>	<b>328<sup>(b)</sup></b>
<b>Supervised postgraduates<sup>(a)</sup></b>					
PhD	523	629	733	655	639
Masters	48	56	47	59	77
Honours	63	58	60	77	64
<b>Total</b>	<b>634</b>	<b>743</b>	<b>840</b>	<b>791</b>	<b>780</b>
<b>Postdoctoral Fellows</b>	<b>301</b>	<b>304</b>	<b>330</b>	<b>333</b>	<b>326</b>

(a) As at 31 May each year. A student may be either sponsored, supervised or both. The total number of individual students sponsored and/or supervised as at 31 May 2012 was 806, including more than 45 supervised in collaboration with CRCs and 73 through the Flagship Collaboration Fund. See glossary page 185 for definition of sponsorship and supervision.

(b) Includes 56 students fully sponsored and 272 students partially sponsored by CSIRO.

## Science Outreach – Program performance

The performance of CSIRO’s Science Outreach Program is assessed through six performance indicators. Table 2.11 provides a summary of progress. More detailed analysis and trend data follows the Table.

**TABLE 2.11: PERFORMANCE INDICATORS FOR PROGRAM 3 – SCIENCE OUTREACH**

KEY PERFORMANCE INDICATOR	TARGET	PERFORMANCE
Utilisation of science outreach programs.	Increasing	CSIRO’s Education Centres experienced a decrease in visitors due to a change in staffing levels at specific locations. Meanwhile, the CSIRO Discovery Centre received 108,060 visitors, 34,288 more than in 2007.  Both the Parkes Radio Telescope and Canberra Deep Space Communication Complex attracted higher numbers than the previous year.
Awareness of science by CSIRO stakeholders.	Increasing	In 2011, 40 per cent of Australians questioned were able to name a contribution CSIRO made to their life. This was three per cent less than in 2010.
Success of participants in the Science Outreach Programs.	Evidence of success	Independent evaluations and surveys confirm high levels of success with key CSIRO outreach programs.
International reach and impact of published journals.	Increase	The international reach and impact of 25 peer reviewed research journals published in partnership with the Australian Academy of Science and other societies continues to grow.
New book titles.	50	42 new book titles were published during the year.
Net Profit from CSIRO PUBLISHING.	Positive	CSIRO PUBLISHING delivered a positive net profit of \$620,000.

### Utilisation of science outreach programs

CSIRO Education continues to offer a range of valued programs to teachers and students. The Science Education Centres hosted over 374,000 students and teachers in 2011. Table 2.12 on page 58 shows there was a decrease of 14,000 students across the Adelaide and Hobart centres, due to staff changes. While both centres are now operating at full capacity, the change in staff temporarily impacted the programs in those locations.

Membership to the Double Helix Science Club suffered due to the lack of a marketing person for most of 2010 and 2011, consequently promotion fell. This has been rectified with the position being filled in November 2011. The magazines, *the Helix* and *Scientriffic*, also suffered from a general decline of people reading paper based material. Digital options will be considered in the near future.

Science by Email continued to increase its readership to 41,204 subscribers. The Maths by Email program was renamed to Maths and Stats

by Email, with subscribers reaching 14,967 at the end of 2011. By December 2011, there were 1,453 Scientists and Mathematicians in Schools partnerships in 1,118 schools. *SCOPE*, the national weekly science TV program, returned to being broadcast on Tuesday afternoons. CarbonKids gained funding from Bayer to expand its activities and had 172 schools registered by December 2011.

CSIRO’s Discovery Centre opened two new exhibitions this year – CLIMATE and FUTURE FOOD. The exhibitions communicate complex CSIRO research in visual ways to a range of audiences. Our public programs continue to be extremely popular, attracting positive media attention. The Discovery Centre manages the Inspiring Australia program in the region on behalf of the ACT Government and the Department of Industry, Innovation, Science, Research and Tertiary Education. Our participation in National Science Week in 2011 exceeded previous years, with 20,000 people attending our Experiment-a-thon.



The new climate exhibit at CSIRO's Discovery Centre.

Visitor numbers to the Parkes radio telescope remained high reaching a total of 96,609 in 2011. The telescope's 50th anniversary celebrations generated additional media attention and increased attendance. Education and outreach programs included monthly amateur astronomy meetings, a teacher's astronomy weekend workshop, an open weekend, a community concert and a university level week-long radio astronomy school. Seven high school work experience students and a CSIRO summer vacation student were also hosted at the centre.

The Canberra Deep Space Communication Complex provided education programs to 11,626 students and educators during 2011. Approximately 6,500 students were in years K–6, 4,500 in years 7–12, 600 undertaking tertiary studies and 900 were educators. Subjects ranged from science, technology, engineering and mathematics, and CSIRO's space exploration activities.

**TABLE 2.12: SCIENCE OUTREACH**

PROGRAM	2007	2008	2009	2010	2011
<b>CSIRO Education Programs</b>					
CSIRO Science Education Centres (visitors)	383,499	390,947	386,500	389,287	374,797
CSIRO Discovery Centre (visitors)	73,772	80,555	94,365	100,920	108,060
Double Helix Science Club (members)	19,545	20,253	19,656	15,821	13,851
Science by Email (subscribers)	28,516	29,560	34,933	38,156	41,204
Maths by Email <sup>1</sup> (subscribers)				9,255	14,967
CREativity in Science and Technology (CREST) (participants)	5,999	8,355	8,801	9,668	8,385
BHP Billiton Science Awards (participants)	4,103	2,568	3,114	3,658	3,770
<b>Other Visitor Centres</b>					
Parkes radio telescope (visitors)	104,783	92,369	112,342	95,104	96,609
Canberra Deep Space Communication Complex (visitors)	62,162	67,538	67,582	70,044	77,350

<sup>1</sup> Launched in 2010

## Awareness of science by CSIRO stakeholders

In 2011, CSIRO commissioned Ogilvy Illumination to conduct an on-line survey into community attitudes towards CSIRO. Questions from a similar survey undertaken in 2010 were repeated to identify any shifts in community awareness. Results confirmed that when Australians think about science and research in Australia, they overwhelmingly think about CSIRO. As in 2010, awareness of CSIRO is still high amongst our community, however, knowledge of recent stories about CSIRO is comparatively low. Furthermore, awareness of the Organisation's achievements is shallow – particularly among younger Australians.

The 2011 survey found that Australians are more likely to have heard about the Organisation through stories that relate to the environment, whereas in 2010, community awareness was greater when the story was about diet and nutrition. The survey also found that the impression recent CSIRO news stories left on Australians was slightly less positive than in 2010 (more information on page 5).

## Evidence of success in the Science Outreach programs

In 2011, an evaluation was completed for Science by Email, where subscribers indicated a high level of satisfaction with the newsletter. Science by Email has been well received at all stages of its history according to in-house surveys completed in 2003, 2007 and 2009. The 2011 evaluation showed that the program is continuing to attract and grow a strong following more than a decade after its formation. The email newsletter is reaching its target audience of 9–13 year olds and their teachers in Australia and overseas. It is also eagerly received by a much broader audience of younger children, young adults and adults who enjoy its currency and immediacy, and want to know more about science.

An external evaluation was also completed for the Scientists in Schools program, where the program was rated as extremely positive in its impact.

BHP Billiton extended the BHP Billiton Science Awards for a further three years and doubled their funding to expand the competition, demonstrating their commitment and how highly they value the awards program.

The Science Education Centres regularly survey teachers who have used our programs. Results



**Student at CSIRO New South Wales Education Centre.**

from over 6,500 teachers across Australia found that approximately 99 per cent of these teachers found our programs both engaging and educational.

Attendance from interstate schools to CSIRO's Discovery Centre continues to increase, with 43,000 students visiting the Centre in 2011–12. Students are taken through a 90-minute minds-on, hands-on program hosted by a team of postdoctoral and PhD students from CSIRO and the Australian National University. The program begins with an overview of CSIRO, its research and achievements. A number of times this year, our high-school age audiences spontaneously burst into applause when told that a CSIRO invention, wireless local area network (WLAN), made wireless hotspots and mobile phone downloads possible. CSIRO Discovery has been working with science units on the Black Mountain site in Canberra, to extend the range of educational experiences on offer, including tours of the High Resolution Plant Phenomics Centre and the CSIRO-hosted national collections.

The Parkes radio telescope visitors centre conducts monthly exit surveys to determine the quality of visitor experience. In 2011, 90 per cent of surveyed visitors rated their experience as 'good' or 'very good', while 65 per cent rated their visit as 'very good'. The centre remains a popular attraction with around 5,000 visitors attending its 50th anniversary celebrations over one weekend during 8–9 October 2011.

The Canberra Deep Space Communication Complex continues to provide a unique science

education and outreach opportunity to the community and students from Kindergarten to Year 12, including tertiary. During 2011–12, a new outreach program was launched utilising social media to encourage conversations about science and planetary exploration. Visitor surveys consistently return positive feedback. Evidence of our education success is seen in the high rate of schools re-booking, with an average of 74 per cent returning each year.

## CSIRO PUBLISHING

### International reach and impact of published journals

The international reach and impact of 25 peer reviewed research journals published in partnership with the Australian Academy of Science and other societies continues to grow, as measured by downloads, impact factors and subscriptions.

Approximately 50 per cent of the articles in the journals were written by Australian researchers, with the balance by overseas authors.

During 2011, 2.6 million journal articles were downloaded from **CSIRO PUBLISHING**'s website, with approximately 40 per cent of these from **CSIRO PUBLISHING**'s archive (see Table 2.13).

CSIRO's *ECOS towards a sustainable future* magazine discontinued publishing in print and adopted a digital-only format. This allowed publication to occur weekly rather than bimonthly. *ECOS* downloads increased by 23 per cent due in part to it being published more frequently.

### New book titles

During 2011–12, 42 new books were published in print and digital formats. Titles featuring CSIRO authors and their research included *Minerals, Metals and Sustainability: Meeting Future Material Needs* and *Biological Control of Weeds in Australia*. A notable highlight was *Burke and Wills: The Scientific Legacy of the Victorian Exploring Expedition*. The book captured a good deal of media attention as it shed new light on an important event in Australia's history. *Science and Solutions for Australia* series continued with publication of the second book *Water*.

### Net Profit from CSIRO PUBLISHING

A positive net profit of \$620,000 was delivered. **CSIRO PUBLISHING**'s total revenue for 2011–12 was \$10.08 million, down slightly on 2010–11 revenue of \$10.23 million. The demand for **CSIRO PUBLISHING**'s products remains strong, even in an environment dominated by global budgetary restraints and new publishing models.

**TABLE 2.13: CSIRO PUBLISHING**

	2007	2008	2009	2010	2011
<b>CSIRO PUBLISHING</b> journal (downloads)	1,432,024	1,686,320	2,092,283	2,633,703	2,653,848
<i>ECOS</i> story (downloads)	168,262	204,225	200,740	241,525	296,448

# Program 4 – National Research Infrastructure: National Facilities and Collections

## National Research Infrastructure – objectives and deliverables

CSIRO manages two types of national research infrastructure on behalf of the nation; National Research Facilities and National Biological Collections. In addition, CSIRO hosts 30 other research facilities and over 30 national reference collections.

## National Research Facilities

CSIRO operates a range of specialised laboratories, scientific and testing equipment, and other research facilities which are available for use by both Australian and international researchers. The three major National Research Facilities, classified as landmark facilities, are:

- ♦ **The Australian Animal Health Laboratory (AAHL)** – located in Geelong, Victoria, is a national centre of excellence in disease diagnosis, research and policy advice in animal health and human diseases of animal origin (zoonoses). It is Australia's front line defence, helping to protect Australia from the threat of exotic (foreign) and emerging animal diseases.
- ♦ **The Australia Telescope National Facility (ATNF)** – operated and managed by CSIRO's Division of Astronomy and Space Science, is made up of radio telescopes at three observatories, near the towns of Parkes, Coonabarabran and Narrabri in New South Wales. A fourth telescope, the next generation Australian Square Kilometre Array Pathfinder (ASKAP) is currently being built at the Murchison Radio-astronomy Observatory in Western Australia and will consist of 36 antennas. The ASKAP will be operational in 2013 as part of the ATNF.
- ♦ **The Marine National Facility (MNF)** – is made up of a 66 metre blue-water research vessel, *Southern Surveyor*, a package of unique scientific equipment and instrumentation, and a collection of 27 years of marine data. It has the scientific, technical and administrative expertise required to safely and effectively manage an ocean-going research platform. The *Southern Surveyor* is particularly suited

to multidisciplinary research projects in the deep oceans surrounding Australia. CSIRO is managing a major project to design and build a new state-of-the-art research vessel, *Investigator*, to replace the *Southern Surveyor*, scheduled to be operational in 2013.

## National Biological Collections

CSIRO is the custodian of four national biological collections:

- ♦ Australian National Insect Collection (ANIC), specialising in Australian terrestrial invertebrates
- ♦ Australian National Wildlife Collection (ANWC), specialising in land vertebrates
- ♦ Australian National Fish Collection (ANFC), specialising in marine fishes
- ♦ Australian National Herbarium (ANH), specialising in our native plants and weeds

and over 20 smaller collections of interest that contribute to the discovery, inventory, understanding and conservation of Australia's biological diversity.

Together, these collections support an important part of the country's taxonomic, genetic, agricultural and ecological research. These vital resources provide correct identification of species for biosecurity, conservation and the development of sustainable land and marine management systems.

## National Research Infrastructure – Program performance

The performance of CSIRO's National Research Infrastructure Program is assessed through six key performance indicators. Table 2.14 on page 62 provides a summary of progress. More detailed analysis and trend data follow the Table.

**TABLE 2.14: PERFORMANCE INDICATORS FOR PROGRAM 4 – NATIONAL RESEARCH INFRASTRUCTURE**

KEY PERFORMANCE INDICATOR	TARGET	PERFORMANCE
Utilisation of the National Research Infrastructure.	Variable	Availability and use of the National Research Infrastructure by Australia and the international scientific community has been maintained at the target levels for National Research Facilities. The total number of visitors and tours hosted for National Biological Collections decreased between 2010–11 and 2011–12 as outlined in Table 2.15.
Maintenance and operation of National Research Infrastructure.	International Standard	Management arrangements continue to be strengthened to ensure operations are being adequately maintained. Compliance with relevant Australian and international standards is being achieved, including the auditing of facilities by the various regulators.
Proportion of National Biological Collections digitised and available to the public.	Increase	The proportion of specimen material digitised in the four national biological collections increased slightly. Public availability of <i>The Atlas of Living Australia</i> (see: <a href="http://www.ala.org.au">www.ala.org.au</a> ) provides open and free access to biodiversity data held by these collections and others.
Coverage of National Biological Collections.	Increase	The taxonomic coverage of Australian species remained largely unchanged in the year, except for fish species, which increased by three per cent.
Response to national events.	Timely response	AAHL continues to respond to national events in a timely manner. All 48,500 tests on around 31,000 samples sent for diagnostic testing for exotic diseases were completed in 24 hours or less. During the year, a record number of cases of the Hendra virus in horses in New South Wales and Queensland were noted, with more incidents recorded this year than the total for all previous cases combined.
Scientific contributions in support of research.	Demonstrated high-quality contributions	CSIRO's National Research Infrastructure continues to provide significant support and opportunities for collaboration with the Australian and international scientific communities. Achievements this year are described on pages 66–68.

## Utilisation of National Research Infrastructure

Statistics relating to the use of the National Research Facilities are provided in Table 2.15.

**TABLE 2.15: UTILISATION OF NATIONAL RESEARCH FACILITIES**

ACCESS TO NATIONAL RESEARCH INFRASTRUCTURE	2008–09	2009–10	2010–11	2011–12
<b>Australian Animal Health Laboratory</b>				
Hours operating per day	24	24	24	24
Days operating per week	7	7	7	7
<b>Australia Telescope National Facility<sup>1</sup></b>				
Time allocated to observations (%)	76	75.3	72.4	73.6
Time lost to equipment failure (%)	3	2.9	3.1	2.7
Time allocated to CSIRO staff (%)	20	24	24	22
Time allocated to other Australian researchers (%)	30	23	25	21
Time allocated to international researchers (%)	50	53	51	57
<b>Marine National Facility</b>				
Ship time grants (days)	99	177	169	176

1 More information can be found in the ATNF's Annual Report, see: [www.atnf.csiro.au/AR2011](http://www.atnf.csiro.au/AR2011)

In November 2011, the world’s most advanced bio-secure laboratory – the **AAHL Collaborative Biosecurity Research Facility** (ACBRF) – was officially opened by the then Minister for Innovation, Industry, Science and Research, Senator the Hon Kim Carr. This specialised biosecurity infrastructure has extended AAHL’s ability to deal quickly and effectively with a wide range of emerging diseases that have the potential to harm humans and animals. The Australian Government funded the construction of the ACBRF through the National Collaborative Research Infrastructure Strategy (NCRIS).

Demand by prominent astronomers, from Australia and overseas, for use of the **Australia Telescope National Facility** (ATNF) remains high. This is evident with telescopes over-subscribed by up to a factor of 2.6 at peak observation times. The ATNF exceeded its target of 70 per cent of time allocated for astronomical observations on the Australia Telescope Compact Array and Parkes Telescope. Time lost during scheduled observations due to equipment failure was below five per cent. Performance targets were also met on the Mopra Telescope and Long Baseline Array. Over 100 papers using ATNF data were also published in refereed journals in the reporting year.

The **Marine National Facility** (MNF) provided 176 days of ship time out of 405 days requested by researchers and a possible 180 days at sea. Participants included scientists from 18 Australian institutions including CSIRO, Geoscience Australia, the Bureau of Meteorology, the Australian National University, the University of Wollongong, the Western Australian Department of Fisheries, the Royal Australian Navy and collaborating scientists from institutions in Belgium, France, Israel, the Netherlands, New Zealand and the USA. The MNF fostered the development of next generation marine researchers by enabling 25 students to experience scientific work at sea.

Use of the **National Biological Collections** across a number of metrics decreased in the past year (see Table 2.16). Reduced staffing to support access to the collections has had a major impact on physical use, particularly in the ANIC. However, web portals such as *The Atlas of Living Australia* and *Australia’s Virtual Herbarium* provide new avenues for virtual access of collection material. Downloads per record in 2011–12 ranged from 3 to over 20 across the four collections, which demonstrates strong interest in accessing data about the collections. The collections have now been assembled with four others as the Australian National Biological Collections Facility under common leadership to enhance their maintenance, research and access.

**TABLE 2.16: COMBINED UTILISATION OF NATIONAL BIOLOGICAL COLLECTIONS**

USE OF NATIONAL BIOLOGICAL COLLECTIONS	2008–09	2009–10	2010–11	2011–12
Number of specimens dispatched	7,800	29,300	25,925	15,548
Outward going loans	138	147	193	157
Tissue samples sent	3,300	3,800	4,447	3,819
Tissue sample grants	79	44	40	43
Number of visitors hosted	155	186	336	267
<b>Total visitor research days</b>	<b>403</b>	<b>713</b>	<b>551</b>	<b>800</b>
Number of tours hosted	47	57	70	52
<b>Total number of visitors on tours</b>	<b>535</b>	<b>597</b>	<b>1,266</b>	<b>363</b>

## Maintenance and operation of National Research Infrastructure

The **AAHL** laboratory continues to retain accreditation to ISO/IEC 17025:2005 and certification of its management system to AS/NZS ISO 9001:2008 and environmental management system to AS/NZS ISO 14001:2004. AAHL expanded its function as an international proficiency testing provider for exotic disease agents and has achieved accreditation to ISO/IEC 17043.

Compliance with the Australian Quarantine Inspection Services, the Office of the Gene Technology Regulator and those regulations concerning Security Sensitive Biological Agents has been achieved. Many of these regulations have been enhanced and expanded in response to maximising effective risk management in these areas. Auditing of the new facilities (the PC4 laboratory and the insectary) by the various regulators has been successful with only minor modifications required to ensure full compliance.

The safety of staff is paramount at all times and a rigorous program of microbiological and safety training is provided throughout the year.

The **ATNF** is continuing to maintain and upgrade existing instrumentation and improve the standardisation of equipment across all its observatories. New 16 centimetre receivers were installed on all antennas of the Australia Telescope Compact Array. A significant amount of work has been carried out on the Parkes Telescope in preparation for observations to be conducted remotely from the observatory, while ensuring the telescope and its systems are safely protected.

CSIRO is managing the building of a new state-of-the-art **MNF** research vessel to replace the current vessel *Southern Surveyor*, which is scheduled to be decommissioned in 2013. The 41-year-old *Southern Surveyor* will undertake numerous voyages in its final months, made possible through an enhanced maintenance program of \$887,000 in 2011–12. Progress with the new vessel, the *Investigator*, is well underway. A blog on CSIRO's web site has been developed to keep the general public informed about the progress of the project (see: [www.csirofrvblog.com](http://www.csirofrvblog.com)). The new vessel is larger and capable of supporting more days at sea per annum.

## National Biological Collections

During 2011–12, the National Biological Collections developed plans for their future infrastructure needs as a number of the collections are nearing capacity and have ageing facilities. The **ANWC** and the Dadswell Wood Collection need to be relocated to Black Mountain, Canberra in the next few years.

The **ANH** has processed a number of scientifically and historically significant specimen donations, totalling over 2,300 specimens, further reducing the ANH collections backlog and increasing specimens and data available for research. Additional valuable collections have also been accessioned through staff participation in a survey of Christmas Island, and 'Bush Blitz' survey expeditions to the monsoon Northern Territory and the Tasmanian Highlands.

The **ANIC** has prioritised the digitisation of the bee and cicada collections, which will contribute primary biodiversity data and multimedia from these groups to a national initiative in collaboration with *The Atlas of Living Australia* (ALA) ([www.ala.org.au/](http://www.ala.org.au/)). In addition, the ANIC received several important donations of material, including a collection of butterflies that added significant value to the ANIC's collection of Gondwanan Lepidoptera specimens.

The **ANFC** is a purpose-built facility and is maintained and operated to the standards expected for a collection of international standing. All specimens and samples are prepared using standard internationally-recognised museum procedures.

## Proportion of collections digitised and available to the public

The proportion of specimen level material digitised in the four collections ranges from 5 to 100 per cent (see Table 2.17).

**TABLE 2.17: DIGITISATION OF THE NATIONAL BIOLOGICAL COLLECTIONS**

COLLECTION	PROPORTION OF COLLECTION DIGITISED (%)		
	2009–10	2010–11	2011–12
Australian National Insect Collection	2.9	5	5
Australian National Wildlife Collection (excluding sound collection)	86	91	91
Australian National Fish Collection	100	100	100
Australian National Herbarium	76	76	76

Most of these digital records are available to the public and to researchers through the ALA. In this last year, the functionality of the ALA has been extended with the release of the *OzAtlas* mobile application for smart phones and tablet computers. This allows mobile data capture into the ALA and gives access to data and images for Australian species and their distribution, including on-line field guides for species within a given locality.

Digital records of individual insect specimens from the **ANIC** have been supplemented by new digitisation techniques, which allow a whole drawer of insects to be rapidly photographed and analysed. This has enabled faster delivery of specimen data to users. The ANIC is focusing on digitising the most scientifically valuable specimens to be made publicly available on-line, thus increasing digitisation rates across the whole collection.

The **ANWC's** collections of birds, mammals, reptiles and amphibians comprise dried skins, skeletal specimens, whole specimens in alcohol and eggs. They have been almost completely digitised, even as the collection grows, and the records are available on the ALA. The Sound Library and recently collected subfossil material are in the process of being digitised using new databasing methods.

The **ANFC** specimen data (49,158 records) is 100 per cent digitised and approximately 57 per cent is available publicly through the On-line Zoological Collections of Australian Museums ([www.ozcam.org.au/](http://www.ozcam.org.au/)) and the ALA.

The majority of **ANH** Australian specimen records are digitised and available through *Australia's Virtual Herbarium* ([www.chah.gov.au/avh](http://www.chah.gov.au/avh)) and through the ALA. The remaining undatabased collections (approximately 24 per cent) are primarily of non-Australian origin. Images of Australian plants are also available via the Australian Plant Image Index ([www.cpbr.gov.au/photo/](http://www.cpbr.gov.au/photo/)), a comprehensive collection of over 65,000 images.

### Coverage of the National Biological Collections

The National Biological Collections provide a broad coverage of Australian species (see Table 2.18), although in the national context the collections have focused on building strength in particular areas.

**TABLE 2.18: COVERAGE OF THE NATIONAL BIOLOGICAL COLLECTIONS**

COLLECTION	PROPORTION OF DIVERSITY COVERED (%)		
	2009–10	2010–11	2011–12
Australian National Insect Collection	70	70	70
Australian National Wildlife Collection	Birds – 99 Other vertebrates – 55	Birds – 99 Other vertebrates – 55	Birds – 99 Other vertebrates – 55
Australian National Fish Collection	50	54	57
Australian National Herbarium	70	70	70

## Demonstrated response to national events

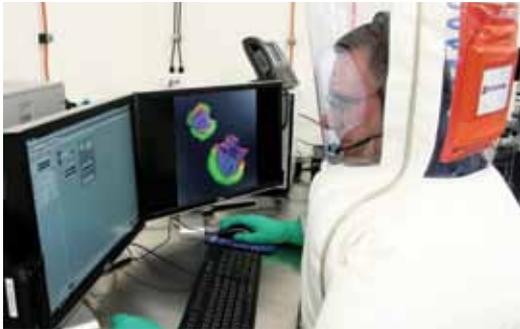
**AAHL** continued to ensure that all diagnostic testing met nationally agreed turn around and reporting timelines, with those involving exotic agents requiring a 24 hours or less response.

During the reporting year, some 48,500 tests were conducted on around 31,000 samples. There was an unprecedented increase in the number of cases of Hendra virus in horses in New South Wales and Queensland, with more incidents recorded this year than the total of all previous cases combined.

2011–12 also saw the first recorded cases of Pigeon Paramyxovirus in Australia, where AAHL provided rapid diagnostic capabilities.

## Scientific contributions in support of research

This section highlights some of the high-quality scientific contributions made by the National Facilities and Collections in 2011–12.



**Dr Glenn Marsh working at the highest level of biosecurity at AAHL.**

### AUSTRALIAN ANIMAL HEALTH LABORATORY

AAHL continues to develop capabilities and partnerships for best managing the risks from infectious agents to livestock, people and our environment. It does this by providing access to its world-class high containment facility to Australian researchers. Currently, infectious disease experts from Deakin University are partnering with AAHL to utilise the unique infrastructure and cutting-edge technology that AAHL offers.

During 2011–12, AAHL scientists produced a new experimental vaccine to protect horses against the deadly Hendra virus. AAHL is now working closely with a commercial manufacturer to prepare for large-scale production of the vaccine for wide spread use. If trials and evaluations are successful, the vaccine could be available for limited field trials by late 2012, with a target of 2013 for final release.



**Confetti cannons fire in celebration of the Parkes Observatory 50th Anniversary.**

### AUSTRALIA TELESCOPE NATIONAL FACILITY

The Parkes Telescope, one of the ATNF's suite of telescopes, celebrated its 50th birthday in October 2011, with the occasion marked by a symposium highlighting five decades of scientific research. The Parkes Observatory also hosted the annual Radio School, with a week of lectures and hands-on observing experience for the next generation of telescope users.

Observations made with the Parkes Telescope were used to infer the existence of a 'diamond planet', a planet almost certainly crystalline in nature, in our galaxy, which attracted considerable media interest.



**Sediment grab sampler being retrieved on the *Southern Surveyor*.**

#### **MARINE NATIONAL FACILITY**

The Marine National Facility research vessel, *Southern Surveyor*, deployed deep water moorings off the coast of Brisbane to enable the long-term monitoring of the Eastern Australian Current. The data collected will be crucial for climate model development and understanding Australia's changing marine environment.

Deep water moorings were also deployed off the south coast of Tasmania, to measure carbon dioxide exchange between the air and the ocean and its movement within the Southern Ocean – an ocean that is recognised as an important driver of regional and global climate. This provides essential information to understand past and projected future climate states and inform responses to climate change.

On a voyage off Western Australia, where Australia separated from India during the eastern Gondwana breakup, scientists mapped previously unexplored seafloor to provide insights into its geological history and deep earth resources. Exciting results included the discovery of an underwater micro-continent, a fragment of the breakup process.



**The ANIC Collection Manager, Dr Beth Mantle, viewing specimens of the Ulysses butterfly, *Papilio ulysses*.**

#### **AUSTRALIAN NATIONAL INSECT COLLECTION**

During 2011–12, the ANIC conducted, in collaboration with researchers from the Barcode of Life, Canada, a 'barcode blitz' on butterflies and moths, where DNA was extracted and analysed from over 28,000 specimens. This represents over 8,000 species. Despite an average age of 30 years, DNA sequences were recovered from more than 95 per cent of specimens, providing the first continent-wide data set for a mega-diverse insect group in Australia. These findings have proved that the existence of natural history collections are valuable for fast-tracking the development of comprehensive DNA barcode libraries.



***Eucalyptus recurva*, an intriguing endangered species from south-eastern New South Wales. Image: Mike Crisp**

#### **AUSTRALIAN NATIONAL HERBARIUM**

A major research focus for the Herbarium has been integrating evolutionary and geographic information to improve conservation decision-making.

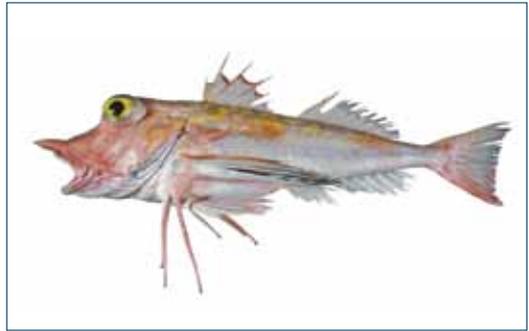
We have developed methods to identify areas of high biodiversity significance in Australia, focusing on wattles, eucalypts, orchids, ferns and mosses. Working with government agencies, we are assessing how well biodiversity is represented in nature reserves across Australia, and the impacts of intensified cropping on biodiversity patterns in the ‘high rainfall zone’, from Townsville in Queensland, to Tasmania and south-west Western Australia.



**The Tawny-crowned Honeyeater *Glyciphila melanops* was a key species in a recent ANWC study. Image: Lynn Pedler**

#### **AUSTRALIAN NATIONAL WILDLIFE COLLECTION**

The ANWC continues its innovative analyses of DNA sequences from native birds. These analyses help us to understand how various species have evolved in their particular niches in Australia’s harsh environments. They also continue to deepen our understanding of how and when evolutionary connections have been formed and broken between birds in Australia and New Guinea.



**Saumarez Gurnard (*Pterygotrigla saumarez*), a new species described in 2012 using ANFC specimens.**

#### **AUSTRALIAN NATIONAL FISH COLLECTION**

The ANFC contributes significantly to the understanding and management of Australia’s marine biodiversity, providing essential expertise to the National Research Flagships Program. As part of *The Atlas of Living Australia* and the Wealth from Oceans Flagship, CSIRO’s Photographic Index of Australian Fishes and marine bioregionalisation initiatives, have been used to create an on-line mapping and identification tool for Australian marine fishes (about 4,500 documented species). When released in late 2012, this tool will enable users to create customised, illustrated species lists for any region of Australia’s marine jurisdiction.

# Program 5 – Science and Industry Endowment Fund

## SIEF – objectives and deliverables

The Science and Industry Endowment Fund (SIEF) is a separately constituted trust under the *Science and Industry Endowment Act 1926* and makes strategic investments in scientific research for the purpose of supporting scientific and industrial research for the benefit of Australia and its people.

The SIEF makes strategic investments in scientific research that addresses issues of national priority for Australia. The Fund invests in science that contributes to Australia’s sustainable future such as:

- ◆ fundamental research for sustainable resource use, environmental protection and community health
- ◆ tactical research addressing solutions to national challenges
- ◆ collaborative research that brings together organisations capable of working together on solutions to national challenges
- ◆ scholarships that create and sustain young researchers capable of addressing national challenges.

Recognising that science has been, and will be, a key driver of the economic, industrial, environmental, and cultural development of Australia, the SIEF invests in research that will contribute to the sustainable growth of Australia.

The Chief Executive of CSIRO, Dr Megan Clark, is the Trustee of the Fund. Dr Clark is assisted by the SIEF Advisory Council, which provides independent advice and recommendations to the Trustee in relation to the making of grants and funding of proposals out of the assets of the SIEF. The Fund is managed by CSIRO on behalf of the Trustee.

Funding is awarded by the Trustee, with advice from Australian and international experts, to proponents from across the National Innovation System. Some of the programs are operated on a competitive basis, and others are operated by invitation on the basis of identified needs of the Australian science community.

The SIEF delivers funding via a number of programs:

- ◆ Research Project grants (competitive)
- ◆ Research infrastructure grants
- ◆ Special research program grant (Synchrotron science)
- ◆ Joint chair appointment (CSIRO/Macquarie University)
- ◆ Research fellowships/scholarships (competitive).

## SIEF – Program performance

The performance of SIEF is assessed through four performance indicators. Table 2.19 provides a summary of progress. More detailed analysis follows the Table.

**TABLE 2.19: PERFORMANCE INDICATORS FOR PROGRAM 5 – SIEF<sup>1</sup>**

KEY PERFORMANCE INDICATOR	PERFORMANCE
Proportion of projects involving research in National Research Priority areas	100% Research Projects 76% Promotion of Science
Number of publications from SIEF projects	79
Proportion of projects involving more than one organisation	more than 85%
Financial contributions of partners	approximately 57%

<sup>1</sup> For all projects awarded as at 30 June 2012.

Key performance indicators for SIEF have been chosen to address the objectives of the early stages of this program. New performance indicators will be added in the future as the programs mature.

### Proportion of projects involving research in national research priority areas

A key selection criterion for all funded programs is addressing national challenges. This criterion is given greater emphasis for the more substantial Research Projects grants (resulting in 100 per cent alignment with national research priority areas). Some latitude is applied in relation to the SIEF Promotion of Science programs, which primarily consists of smaller grants for scholarships and fellowships. This program emphasises support of early career researchers in areas of Australian strength, such as astronomy.

### Number of publications arising from SIEF-funded projects

Publications are a trailing indicator of progress. As SIEF-funded Research Projects generally have a three to five year lifespan and most have commenced relatively recently (many within the 2011–12 reporting period), this metric is expected to increase in future years as projects mature and outcomes are documented.

### Proportion of projects involving more than one organisation

Collaboration is another key (but not mandatory) selection criterion for all funded projects. Ten of the 12 SIEF-funded Research Projects are collaborations, with later selection Rounds (Round 3) all having multiple partners involved. The number of partners for all Research Projects range between one and seven (average three). Strong collaboration can be seen in the scholarships and fellowships programs with 93 per cent of scholars/fellows having co-supervisors from more than one organisation.

### Financial contributions of partners

Commitment to SIEF collaborations can be seen by cash and/or in-kind co-contributions by grant recipients. For all awarded Research Projects, the average co-contribution by collaborators is 58 per cent of total expenditure (approximately \$11 million average total expenditure per Research Project). The average co-contribution towards consumables, travel expenses, access to facilities for scholarship and fellowship grants is 42 per cent, which is in addition to time commitments by supervisors.

# Intellectual property and equity portfolio

## Intellectual property management and licensing

CSIRO manages its intellectual property (IP) using the framework provided by the *Statement of IP Principles for Australian Government Agencies*. This ensures effective identification, protection, ongoing management and exploitation of IP.

During 2011–12, the portfolio experienced growth and change across most IP categories (see Table 2.20). In particular, foreign plant breeder's rights increased significantly by 45 per cent. CSIRO remains Australia's largest patent holder and is proactive in seeking partners to commercialise its IP.

CSIRO executes around 80 new commercial licenses every year, many of these licenses are with small-to-medium enterprises (SMEs). Of the total 4,071 IP registrations and applications (including patents, trade marks, designs and plant varieties), 1,815 are either involved in commercial license arrangements or utilised in collaborative activity with third parties.

**TABLE 2.20: CSIRO INTELLECTUAL PROPERTY BY TYPE**

IP CATEGORY <sup>1</sup>	SUB CATEGORY	2007–08	2008–09	2009–10	2010–11	2011–12
Patents	Current PCT <sup>2</sup> applications	111	97	90	101	98
	Granted	1,933	1,625	1,630	1,631	1,649
	Live cases	3,787	3,710	3,379	3,370	3,582
Inventions	Patent families	741	743	712	709	728
	New	67	80	99	92	95
Trade marks	Australian	291	265	263	259	275
	Foreign	113	130	114	109	81
Plant breeder's rights	Australian	122	122	122	122	83
	Foreign	25	25	21	21	39
Registered designs	Australian	2	2	2	2	3
	Foreign	11	10	10	10	8

1 IP categories are defined in the glossary on page 185.

2 Patent Cooperation Treaty.

In 2011–12 Starpharma (ASX:SPL) reached a milestone of \$500 million estimated market value. Starpharma was founded on technology originally discovered at the Biomolecular Research Institute, a joint venture between CSIRO and the Victorian State Government. Starpharma is Australia’s third largest publicly listed biotechnology company. Having developed and commercialised dendrimer technology (a type of synthetic nanoscale polymer), Starpharma has grown to become one of Australia’s biotechnology success stories. Its lead product, VivaGel, is currently in Phase 3 trials for treatment of bacterial vaginosis, and the company also has dendrimer development programs in both drug delivery and agrochemicals that are producing promising results.



To support the growth of the IP Portfolio, CSIRO places significant focus on strategic engagements and collaboration with industry partners. In 2007, CSIRO established the Australian Growth Partnership (AGP) program to increase engagement with Australian SMEs. The AGP program provides funds to high potential, technology-receptive SMEs so they can access CSIRO research and development capability and

IP. It is designed to be mutually beneficial by assisting SMEs to overcome existing technical issues, while contributing to CSIRO’s National Research Flagships Program. As at 30 June 2012, six SMEs were engaged in the AGP program.

### Equity portfolio

2011–12 was a challenging year for CSIRO’s equity portfolio. The total value of CSIRO’s equity portfolio at 30 June 2012 was \$17.1 million across listed and unlisted companies. Based on our shareholdings, this translates into a market capitalisation of approximately \$832 million. Revenues from these companies added approximately \$120 million to Australia’s gross domestic product and employed 279 people.

CSIRO’s overall total equity portfolio decreased significantly from 30 June 2011. Major contributing factors were the decrease in value of listed companies due to ongoing unfavourable market conditions and the declining shareholding value of a number of the unlisted portfolio companies. There have been no new spin-out companies formed during 2011–12, however, as Table 2.21 indicates, some of the portfolio companies have raised funds from the capital markets during the year to help fund ongoing commercialisation activities.

CSIRO directly creates new high technology SMEs through spinning out IP when that is deemed to be the best available pathway to commercialisation. CSIRO currently has interests in 34 companies. The broader impact of CSIRO’s recent spin-out companies on the economy has been estimated as nearly \$1 billion in market capitalisation.

**TABLE 2.21: PORTFOLIO MOVEMENTS AND ACTIVITY DURING 2011–12**

ACTIVITY	NUMBER OF COMPANIES	VALUE (\$M)
Companies created	0	0
New capital raised <sup>1</sup>	5	60.35
New CSIRO equity contributions	7	2.76
Wound-up	1	0

1 Capital raised from all sources by companies within the portfolio.

# Awards and honours

Outstanding performance in research is recognised by various international and national award schemes. Here are just a few examples of awards and honours granted in 2011–12 that demonstrate our effectiveness in research and its application in industry and the community.

## Order of Australia

### OFFICER (AO)

**Dr Tom Denmead** (Land and Water Fellow) for distinguished service to environmental research in the fields of crop and soil sciences, physical ecology and micrometeorology, and through the development of improved agricultural practices.

**Mr Simon McKeon** (CSIRO Board Chairman) for distinguished service to business and commerce through leadership and advisory roles, and to the community as a supporter of national and international charitable, educational and sporting organisations.

**Dr Richard Miln Smith** (formerly Human Nutrition) for distinguished service to scientific research in the fields of human nutrition, cardiovascular disease and agriculture, to Indigenous communities in rural and remote areas, and to professional organisations.

### MEMBER (AM)

**Mr Edward (Ted) Edwards** (Ecosystem Sciences Fellow) for service to science in the field of entomology, particularly moths and butterflies, as an author and researcher, and as a mentor.

**Dr Glen Kile** (former Chief of Forestry and Forest Products) for service to forest science, biosecurity and sustainable forestry through research, leadership and management.

**Dr Graham Sparrow** (Process Science and Engineering Fellow) for service to mineral chemistry and to the mining industry as a research scientist and project manager in the development of metallurgical processes for upgrading Australia's mineral resources.

### MEDAL (OAM)

**Dr Brian Cooke** (formerly Ecosystem Sciences) for service to conservation and the environment through biological management programs for rabbit population control.

### PUBLIC SERVICE MEDAL (PSM)

**Dr Michelle Storey** (Square Kilometre Array) for outstanding service in supporting CSIRO's radio astronomy objectives and working with the Australian, Western Australian and New Zealand Governments in their bid to host the future Square Kilometre Array radio telescope project.

### PRIME MINISTER'S SCIENCE PRIZE

**Dr Ezio Rizzardo** (Materials Science and Engineering) and **Professor David Solomon** (University of Melbourne, formerly CSIRO) were recognised for their long and distinguished research careers that led to a revolution in polymer science, profoundly impacting the level of control we have over polymer structure and function (more on page 55).

### AUSTRALIAN MUSEUM EUREKA PRIZES 2011

**Dr John Arkwright** (Materials Science and Engineering) was awarded the Eureka Prize for Innovative use of technology for the creation of a fibre-optic catheter that is opening up new paths for the advanced treatment of colonic diseases and conditions.

**Dr Wojciech (Voytek) Gutowski** (Materials Science and Engineering) was awarded the Eureka Prize for Commercialisation of Innovation for developing the first true zero-waste coating technology that completely eliminates solid and liquid waste, volatile organic chemicals and the use of water in a range of industries that led to powder-coat products.



**Winners of the Chairman's Medal: the Cotton Breeding and Biotechnology Team (left to right) Mr Simon McKeon AO (Chairman, CSIRO Board), Ms Jackie Oliver, Ms Kellie Cooper, Ms Kay Smith, Mr Chris Tyson, Ms Sandra Magann, Mr Scott McCarron, Ms Judith Gaudron, Mr David Shann, Dr Greg Constable, Dr Warwick Stiller. Absent: Mr Chris Allen, Mr Max Barnes, Mr Deon Cameron, Ms Dee Hamilton, Ms Ammie Kidd, Mr Sam Lee, Dr Shiming Liu, Dr Danny Llewellyn, Mr Tom O'Connor, Ms Judy Radik, Mr Peter Reid, Ms Marilyn Smith, Ms Megan Smith and Ms Rebecca Warnock. Image: Simon Ferrito**

#### **CSIRO CHAIRMAN'S MEDAL**

The Chairman's Medal honours the most exceptional research in CSIRO and is awarded to the scientist or team whose research is of national or international importance in advancing scientific knowledge, technology application or commercialisation.

The winners of the *2011 Chairman's Medal* were **Dr Greg Constable** (team leader) and the **Cotton Breeding and Biotechnology Team**. The team received the award in recognition of the major impact achieved on Australia's cotton production due to the breeding and deployment of a new cotton variety.

Further information on CSIRO Awards can be found at: [www.csiro.au/CSIROChairmansMedal](http://www.csiro.au/CSIROChairmansMedal)

#### **THE CSIRO MEDAL FOR LIFETIME ACHIEVEMENT**

The CSIRO Medal for Lifetime Achievement is awarded to individuals who have a record of sustained and meritorious achievement over a prolonged period of CSIRO service.

The 2011 winner was **Dr Trevor Bird** (ICT Centre) for his inspirational leadership and outstanding technical contributions to the international satellite industry and radio astronomy. In particular, for design techniques and innovations for multibeam antennas now employed in both applications world-wide.

