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Citations:

Bluebook 21st ed.

J. B. Ruhl & James Salzman, A Global Assessment of the Law and Policy of Ecosystem Services, 39 U. Queensland L.J. 503 (2020).

ALWD 7th ed.

J. B. Ruhl & James Salzman, A Global Assessment of the Law and Policy of Ecosystem Services, 39 U. Queensland L.J. 503 (2020).

APA 7th ed.

Ruhl, J. J., & Salzman, J. (2020). Global Assessment of the Law and Policy of Ecosystem Services. University of Queensland Law Journal, 39(3), 503-524.

Chicago 17th ed.

J. B. Ruhl; James Salzman, "A Global Assessment of the Law and Policy of Ecosystem Services," University of Queensland Law Journal 39, no. 3 (2020): 503-524

McGill Guide 9th ed.

J. B. Ruhl & James Salzman, "A Global Assessment of the Law and Policy of Ecosystem Services" (2020) 39:3 U Queensland LJ 503.

AGLC 4th ed.

J. B. Ruhl and James Salzman, 'A Global Assessment of the Law and Policy of Ecosystem Services' (2020) 39 University of Queensland Law Journal 503.

MLA 8th ed.

Ruhl, J. B., and James Salzman. "A Global Assessment of the Law and Policy of Ecosystem Services." University of Queensland Law Journal, vol. 39, no. 3, 2020, p. 503-524. HeinOnline.

OSCOLA 4th ed.

J. B. Ruhl & James Salzman, 'A Global Assessment of the Law and Policy of Ecosystem Services' (2020) 39 U Queensland LJ 503

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A GLOBAL ASSESSMENT OF THE LAW AND POLICY OF ECOSYSTEM SERVICES

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This article assesses the approaches that different national governments have employed to provide and conserve ecosystem services, focusing on policy instruments and common-law court decisions. Applying the lessons learned from this review, we address strategies for conservation of mangrove ecosystem services in Australia, focusing on the importance of creating a strong political mandate and demonstrating a clear connection between mangrove conservation and the benefits provided by mangrove services. This requires further research on which beneficiaries would be harmed, and by how much, if the mangrove service flows are reduced. Policy uptake can be slow. It has taken years in other jurisdictions for policies protecting ecosystem services to be adopted, and this will likely be the path in Australia as well.

I INTRODUCTION

Humanity has always benefited from our environment. Ecosystem *goods* — the physical items that an ecosystem provides — are obvious. We look to forests for timber, and coastal marshes for shellfish. Less visible, though no less important, our environment also provides *services*. These ecosystem services provide the conditions and processes that sustain human life.¹ If you doubt this, consider how to grow an apple without pollination, pest control or soil fertility.

Once one realises the importance of ecosystem services, three points quickly emerge: (1) landscapes provide a stream of services ranging from water quality and flood control to climate stability, the economic value of which can be significant; (2) the vast majority of these services are public goods and not exchanged in markets, and so landowners have little incentive to provide these positive externalities; and (3) government therefore needs to think creatively about policies to provide these services.

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¹ See, eg, Gretchen C Daily (ed), *Nature's Services: Societal Dependence on Natural Ecosystems* (Island Press, 1997) 3.

This article assesses the different approaches that governments around the globe have employed to provide ecosystem services, spanning the breadth of policy instruments as well as court decisions. We use mangroves in Australia as a common example throughout. In Part II, we use the framework of ‘the Five P’s’ to lay out the different types of government policies to protect ecosystem services, with a particular focus on payments. In Part III, we focus on the role of common-law court doctrines to protect ecosystem services. Part IV recommends policy tools to protect and enhance the services provided by mangrove ecosystems.

II ECOSYSTEM SERVICES AND THE FIVE P’S

Despite the complexity of environmental law and policy, there are only five basic policy instruments that governments can apply. These can be captured through a simple framework known as ‘the Five P’s’. These include Prescriptive Regulation, Property Rights, Penalties, Persuasion, and Payments.² There will rarely be one best tool for a particular situation, and much of the challenge in instrument choice lies in identifying each instrument’s particular advantages and disadvantages. In the sections below, each policy approach is set out and applied to the protection of mangrove ecosystem services.

A *Prescriptive Regulation*

Prescriptive regulations mandate what parties can and cannot do. This is both the most direct and the most common form of environmental law. We see prescriptive regulations at all levels of environmental governance — from hunting permits at the local level and effluent limits under pollution laws at the national level, to restrictions on foreign commerce in endangered species at the international level.³ Also referred to as *command-and-control regulation*, prescriptive regulation can be very effective in mandating uniform compliance across all actors, preventing problems of free-riders and a race to the bottom. We can see this policy instrument in play with mangroves through the requirement of a permit for development that will destroy or degrade mangroves.⁴ No permit, no development.

² See James Salzman, ‘Teaching Policy Instrument Choice in Environmental Law: The Five P’s’ (2013) 23(2) *Duke Environmental Law and Policy Forum* 363.

³ For a thoughtful defence of prescriptive regulation, see Howard Latin, ‘Ideal versus Real Regulatory Efficiency: Implementation of Uniform Standards and “Fine-Tuning” Regulatory Reforms’ (1985) 37(5) *Stanford Law Review* 1267.

⁴ See generally Jody Freeman and Charles D Kolstad (eds), *Moving to Markets in Environmental Regulation: Lessons from Twenty Years of Experience* (Oxford University Press, 2007).

Three unstated assumptions lie behind prescriptive regulation. The first is that the regulator will set the standard at the proper level. This is not a given, either because of inadequate information or agency capture (a classic problem in the context of natural resources such as fish and timber, where industry pressure has led to overfishing and large-scale clearcutting). The second assumption is that the regulator will be able to monitor compliance with the standard. Satisfying both of these assumptions imposes administrative costs that, as result, can sometimes be a good deal higher for prescriptive regulation than for other policy instruments.

The third assumption is that there will be sufficient political will for adoption and enforcement. This is particularly challenging in jurisdictions where development interests are politically powerful. In the case of mangroves, building companies and aquaculture firms fight hard to allow conversion of mangroves, making conservation of services particularly challenging.

B *Property Rights*

This instrument relies on privatising a resource by creating property rights. Compared to prescriptive regulation, this approach should have lower administrative costs. The government simply creates the property rights (whether for grazing, biodiversity or wetland acres), allocates them initially, and steps back, leaving future allocations to the market. Implicit in a 'property rights' approach is the importance of technology. To enforce your right to exclude, you need both to know that someone is making use of your resource (an issue of monitoring capacity) and to have the ability to exclude others' use.

Prescriptive regulations can be combined with property rights through the use of tradable permits in environmental markets. Here, property rights are created for use of the resource. Trading systems use the market to make prescriptive regulation more efficient. The government decides how much of a harmful activity to permit (just as it would with prescriptive regulations), awards private rights to engage in the activity up to the regulatory cap, and then permits those rights to be traded. The market does not play a role in determining the overall level of environmental protection; that is the role of the regulatory regime.

To make this more concrete in the context of ecosystem services, imagine how a trading program would work with mangroves. Policy-makers decide that there should be no net loss of mangroves. The government requires a developer to hold a permit for every hectare of mangrove destroyed. Entrepreneurs create new mangrove areas. These are assessed by a government agency and, if approved, are issued permits that the 'mangrove bankers' can then sell to the developers. If the system works properly, this mitigation or offsets approach will ensure both development and no net loss of mangroves.

Mitigation banks for wetlands and species habitat have grown and now constitute an annual market worth over \$500 million globally.⁵ While relatively simple in theory, this strategy can be difficult to implement. It requires a credible regulatory driver and strong institutional infrastructure. Hence, they are only found in developed countries with robust regulatory regimes.⁶ Determining the appropriate currency has also proven challenging. Should, for example, an offsets program for mangroves require offsets based on hectares developed or loss of services? Put another way, offsets promise no net loss, but one needs to question further: no net loss of what?

C *Financial Penalties*

Short of banning an activity, another effective way to limit behavior that degrades natural capital is to make it more expensive, whether through charges, taxes or liability. By increasing the costs of harmful activities, such penalties force the parties to bear the costs of their activities.⁷ To use economics language, the polluter internalises the negative externalities of her behaviour. In our mangrove example, developers might be charged a fee based on the area converted or loss of service provision. The fee could be shifted up or down, depending on the desired level of services.

In theory, financial penalties offer an attractive policy instrument, but there are two practical obstacles. The first lies in getting the price right. Markets are efficient when the prices for goods accurately reflect their full environmental and social cost. A key aspect in internalising externalities, then, is valuation. If one agrees that externalities should be internalised — that parties should pay for the harm caused — the obvious question is ‘how much’? How much are mangrove services worth, and can they be accurately measured before development, when the fee would need to be paid?

The second challenge is political. Increasing fees is never easy, and environmental charges can seem harder still. And levying them at charges high enough to influence behavior significantly is easier said than done. In many cases, financial penalties for development that causes loss of services have been intended more for revenue-raising than for serious behavior modification.⁸

⁵ James Salzman et al, ‘The Global Status and Trends of Payments for Ecosystem Services’ (2018) 1(3) *Nature Sustainability* 136, 139 (‘Salzman Trends’).

⁶ *Ibid* 138.

⁷ See, eg, Paul Ekins, ‘European Environmental Taxes and Charges: Recent Experience, Issues and Trends’ (1999) 31(1) *Ecological Economics* 39.

⁸ *Ibid*.

D *Persuasion*

If prescriptive regulation and market instruments represent ‘hard’ regulatory approaches, then a softer approach may be found in laws requiring information production and dissemination. The theory behind such approaches is that the government can change people’s behavior by forcing them to think about the harm they are causing and by publicising that harm.⁹ In the context of mangroves, the government might launch an education campaign about the flood control and biodiversity benefits that mangroves provide, or highlight through public service announcements the harms resulting from loss of mangroves. It could launch a ‘naming-and-shaming’ initiative, calling out developers who destroy mangroves. Information-based approaches like this are often used when there is inadequate political support to impose market or regulatory instruments, or when such instruments are ill-suited to the problem.¹⁰

E *Financial Payments*

As noted above, just as government can use penalties to capture negative externalities and make bad activities more expensive, it can use payments to capture positive externalities and make good activities less expensive. In our mangrove example, landowners might be paid for mangrove restoration. This is the approach behind the popular strategy of payments for ecosystem services (‘PES’).

An obscure term just 15 years ago, PES has come of age — whether it is described as ‘natural capital’, ‘nature’s fortune’, or simply ‘investing in nature.’¹¹ There are now over 500 PES programs around the globe, in both developed and developing countries, with annual transactions worth well over \$10 billion.¹²

In economic terms, PES seeks to internalise the positive externalities generated by natural systems, creating incentives for landholder behavior that ensures service provision. In some circumstances, PES can create additional revenue streams for landholders that, on the margin, can push land management toward conservation rather than development. This approach has been described

⁹ Eric WOrts, ‘A Reflexive Model of Environmental Regulation’ (1995) 5(4) *Business Ethics Quarterly* 779. Ibid.

¹⁰ Gretchen C Daily and Katherine Ellison, *The New Economy of Nature: The Quest to Make Conservation Profitable* (Island Press, 2002); Paul Hawken, *The Ecology of Commerce: A Declaration of Sustainability* (HarperCollins, 2010); Mark R Tercek and Jonathan S Adams, *Nature’s Fortune: How Business and Society Thrive by Investing in Nature* (Basic Books, 2013).

¹² Salzman Trends (n 5).

as ‘making trees worth more standing than cut down’.¹³ It is important to recognise, however, that PES captures only a fraction of the values provided by natural systems. Existence values, option values, and many public goods benefits are usually outside the scope of PES mechanisms.

Because PES programs have received extensive attention, we focus on them in particular.¹⁴ There are three broad categories of PES mechanisms:

- *Voluntary PES* — Beneficiaries of ecosystem services agree to compensate landholders for activities that maintain or enhance ecosystem services delivery. There is no sanction for refusing to agree to the transaction. This includes purchase of biodiversity offsets and carbon offsets by extractive industries and companies motivated by corporate social responsibility to reduce their habitat or climate change impacts. These are private transactions where PES operates as a carrot.
- *Subsidy PES* — Public finance payments reward land managers for enhancing or protecting ecosystem services. The buyer is a public entity acting on behalf of the public good and not necessarily a direct beneficiary of ecosystem services enhancement or protection. This includes government programs in Costa Rica and China that pay landholders for reduced deforestation or afforestation activities that enhance flood protection, water quality or other ecosystem services. Here, public funds operate as a carrot.
- *Compliance PES* — Parties facing regulatory obligations compensate other parties for activities that maintain or enhance comparable ecosystem services or goods in exchange for a standardised credit or offset that satisfies their mitigation requirements. This includes water quality trading, wetlands mitigation banking, and the European Union’s emissions trading scheme for greenhouse gases. Because the services are purchased as a means of regulatory compliance, this mechanism operates as a stick.¹⁵

Within these categories there is a wide range of specific mechanisms, reflecting the creativity of policy-makers and entrepreneurs seeking to create revenue streams for service providers. The table below sets out some of the more common PES approaches.

¹³ James Salzman, ‘The Eleventh Annual Gilbert and Sara Kerlin Lecture — Just What is the Emperor Wearing? The Secret Lives of Ecosystem Services’ (2011) 28 *Pace Environmental Law Review* 591.

¹⁴ Robert Costanza et al, ‘Twenty Years of Ecosystem Services: How Far Have We Come and How Far Do We Still Need to Go?’ (2017) 28(A) *Ecosystem Services* 1.

¹⁵ Salzman *Trends* (n 5) 136.

Table 1: PES Approaches

PES Transaction Type	Sector	Dominant Payment Approach	Carrot versus Stick
Public Payment for Water Services ('PWS')	Water	Public Finance	Carrot
Instream Buybacks	Water	Bilateral Deals	Carrot
Trading and Offsets	Water	Credit Trading	Stick
Bilateral PWS	Water	Bilateral Deals	Carrot
Wetland Mitigation	Biodiversity	Bilateral Deals Credit Trading	Stick
Biodiversity Mitigation	Biodiversity	Bilateral Deals Credit Trading	Stick
Voluntary Biodiversity Offsets	Biodiversity	Bilateral Deals	Carrot
Compliance Forest Carbon	Carbon	Offset Trading	Stick
REDD+ Finance	Carbon	Public Finance	Carrot
Voluntary Forest Carbon	Carbon	Offset Trading	Carrot
Certified Commodities	All	Certification and Standards	Carrot

The PES water sector is the most mature in terms of the number of programs, the ages of programs, transaction value, and geographic distribution.¹⁶ Water is the easiest context for PES because the connection between land management in an upper watershed, and the direct health benefits to downstream users appear straightforward. In many cases, transaction costs are low because institutions are already in place to collect funds from diffuse beneficiaries, whether through water utilities, budgets of water agencies or agricultural subsidy programs.¹⁷

The biodiversity PES sector offsets its losses to ensure that it suffers no net loss. This sector is the least developed in terms of geographic scope and most challenging for countries to put in place. Unlike in water PES, where those who receive clean water and protection from flood are straightforward and local, the beneficiaries of biodiversity are often spread out and the specific benefits indirect or nonmaterial. Institutions that can collect fees for their many beneficiaries — like water utilities — do not exist, and common metrics are difficult to determine. Accordingly, there are only 36 countries that employ biodiversity PES programs, and the most successful initiatives rely on regulatory drivers.¹⁸ The very practice of offsetting is controversial. It faces strong opposition from NGOs that do not wish to endorse habitat destruction.¹⁹

The compliance mitigation programs that restore stream and wetland habitat benefit from strong regulations backed by credible enforcement and common agreement on currencies of exchange (such as wetland acreage). This sector is the least transparent. Data on transactions or project implementation are not available. Global transactions are estimated at \$2.5–8.4 billion annually — a wide range indicative of the difficulties in tracking payments.²⁰

Compliance biodiversity offsets and mitigation remain important conservation mechanisms in a small number of developed countries such as the United States and Germany, but they have not significantly spread to other countries. There are no fully operational compliance-driven programs in Africa. While the European Council adopted a 2020 Biodiversity Strategy calling for the EU ‘to ensure no net loss of biodiversity and ecosystem services’, regulations have not been produced on time and the Commission appears to favor a voluntary rather than regulatory approach.²¹ The United Kingdom has similarly backed off

¹⁶ Ibid 136.

¹⁷ Ibid 140.

¹⁸ Ibid 138.

¹⁹ See, eg, Congressional Research Service, *Wetland Mitigation Banking: Status and Prospects* (Report no 97-849, 1997).

²⁰ Salzman Trends (n 5) 137.

²¹ European Union, *The EU Biodiversity Strategy to 2020* (2011) 24.

mandating offsets in favour of voluntary schemes.²² These concerns over the effect that offset rules could have on development suggest that many nations will continue to favor voluntary approaches.

Compensatory mitigation banking is particularly relevant to mangrove services. Transactions are estimated at \$3.6 billion per year.²³ But it has not spread geographically. Almost all the growth has only occurred in countries where wetlands are the largest habitat type offset — the United States, Australia, Canada and Germany. It has been introduced in Malaysia on a voluntary basis, in Northern Mariana Islands for compliance purposes, and is in the process of being piloted in Colombia.²⁴ In developing countries, permittee-responsible mitigation — mitigation by the impacting party or a subcontractor — is the most commonly found option for compliance. However, many countries (including Brazil, Cameroon, China, Colombia, Egypt, India, Mozambique and South Africa) allow developers to compensate in lieu of offsetting, which is generally used to fund conservation projects by the public sector or a Non-Governmental Organisation ('NGO').²⁵

Mitigation banks take on the risks and complexity of undertaking an offset from developers. They are created by entrepreneurs who develop habitat to host particular species and then receive credits from regulators that can be sold to developers to offset or mitigate their projects' harms to species populations. Large mitigation banks can achieve economies of scale in design, maintenance and monitoring. This enables them to protect larger, contiguous areas that offer better ecological payoff than smaller, isolated permittee-responsible mitigation projects. An effective mitigation system requires laws, monitoring of compliance, and tough enforcement.²⁶ Despite the market's size, data on credit prices is hard to find, and relatively little market infrastructure (like brokerages, accounting services and standards) has emerged compared to newer markets like carbon.²⁷ It also remains unclear whether the currency of exchange adequately reflects ecosystem service values and can meaningfully ensure no net loss.

While the well-known PES success stories continue to generate enthusiasm and interest for PES approaches, a close examination of the experiences to date of the many types of PES mechanisms suggests a more nuanced picture. A small

²² Institute for European Environmental Policy, *Biodiversity Offsets: What Did the UK Pilot Scheme Achieve?* (Web Page, 2016).

²³ Salzman Trends (n 5) 139.

²⁴ Ibid 138.

²⁵ Ibid.

²⁶ James Salzman and JB Ruhl, 'Currencies and the Commodification of Environmental Law' (2001) 53(3) *Stanford Law Review* 607.

²⁷ See, eg, Ecosystem Marketplace, *State of Biodiversity Markets: Offset and Compensation Programs Worldwide* (Report, 2015).

number of PES mechanisms (chiefly subsidy watershed, compliance habitat and biodiversity, and carbon offsets) account for the majority of growth in number, volume of transactions, size of transactions and geographic spread.²⁸ The key questions are: (1) Why have some programs grown to scale while others have not? (2) What does this tell us about the broader issue of instrument choice in environmental protection? We suggest that these questions can be addressed through focusing on four key factors: motivated buyers, motivated sellers, metrics, and low-transaction-cost institutions.

As with all exchanges, PES is driven by demand — ie the perceived scarcity of ecosystem services. People do not buy what they feel they do not need. In the PES arena, the scarcity may concern water quality, flood protection, climate stability or biodiversity. If a service is not scarce (or is simply taken for granted), there is no evident need to pay for it. Many PES mechanisms are purely private — eg duck hunters pay farmers to keep grain on their fields or flood them, and cities pay upper watershed land owners to keep trees standing rather than develop. Landholders can choose to enter into these transactions or not. The challenge is that many ecosystem services are public goods whose benefits cannot easily be captured by discrete parties. As a result, complete reliance on private PES transactions will prove insufficient in many settings to ensure the socially optimal level of service provision.

PES instrument design addresses this issue by stimulating transactions through regulation that creates demand. This prevents free-riding and overcomes the collective action costs of organising diffuse beneficiaries. It is thus no surprise that many of the largest PES programs are all based on transactions mandated by compliance PES, such as mitigation banking. This also explains why the PES mechanisms of compliance biodiversity, instream flow and water quality markets remain limited to a small number of developed countries. The necessary governance capacity of laws and institutions to create regulatory demand is absent in most developing countries.

If PES payments are to provide services, then landowners must be paid, and their behaviour must be sufficient to provide the desired service. Moreover, the amount paid to landowners must be competitive with the opportunity costs. Put another way, PES on its own will make trees more valuable standing than cut down only if the service payments to economically motivated landowners are as attractive as the value of timber. But in many settings, the revenue streams from PES will not change landowners' behaviour and may need to be bolstered by regulation or other strategies.

One can also stimulate service provision with subsidies such as watershed PES financed through water utility bills or government payments. Apart from the general debates over whether public funds should be paid to private landowners,

²⁸ See generally Salzman Trends (n 5).

a key practical challenge for PES subsidy programs lies in identifying those landholders that are most important for service provision. This requires an assessment mechanism to ensure the funds are spent most efficiently. There is no real benefit in paying everyone to conserve wetlands. The focus should be on wetlands with the potential to provide the greatest level of storm water protection. Most subsidy programs, however, do not condition payments on service provision capacity, either because of the transaction costs or because of concern over achieving the dual goal of poverty alleviation.

F Summary

The previous sections have set out the policy toolkit for ecosystem services, with a focus on PES. There is no doubt that governments can conserve and promote provision of ecosystem services through application of any of the Five P's. The key question, though, is whether this has happened on the ground.

Numerous governance institutions have embraced ecosystem services as a broad policy goal.²⁹ Yet, with rare exception, these have not progressed beyond aspirational policy statements and vague regulatory provisions, with little meaningful protection and restoration of ecosystem services on the ground in applied contexts.³⁰ Despite the capacity to incorporate ecosystem services more widely and deeply into policy decisions and legal instruments, substantive policies and binding legal provisions are hard to find. Generally, agencies do not explicitly incorporate ecosystem services into permits or performance standards; nor are they routinely considered in planning processes. When statutes or agency regulations and policies do mention ecosystem services, implementation on the ground (eg whether to issue a permit) often fails to consider them meaningfully.

Bell-James has found precisely this situation in Australia. She reports that limited Commonwealth authority impedes the development of nationwide policy and legal frameworks. In Queensland, the resource focus of laws has not incorporated a multiple ecosystem services approach; nor has the protection of specific resources (eg fish habitat, coast) led to explicit regulation to protect services. Land development laws provide exceptions and other 'flexibility' mechanisms, allowing developers and local authorities to continue destruction and degradation of mangroves. As a result, mangrove services receive scant legal protections.³¹

²⁹ Lynn Scarlett and James Boyd, 'Ecosystem Services and Resource Management: Institutional Issues, Challenges, and Opportunities in the Public Sector' (2015) 115 *Ecological Economics* 3.

³⁰ Stephen W Posner, Emily McKenzie and Taylor Ricketts, 'Policy Impacts of Ecosystem Services Knowledge' (2016) 113(7) *Proceedings of the National Academy of Sciences* 1760.

³¹ Justine Bell-James, 'Integrating the Ecosystem Services Paradigm into Environmental Law: A Mechanism to Protect Mangrove Ecosystems' (2019) 31(2) *Journal of Environmental Law* 291.

The potential for agencies to protect and enhance service provision clearly exists, but they have not fully grasped the opportunity. Where else, then, to look?

III JUDGING ECOSYSTEM SERVICES

Most of the attention to the law and policy of ecosystem services has focused on the incorporation of the ecosystem services framework by legislatures in statutes and by administrative agencies in their regulations and policies, using the Five Ps.³² But judges, particularly in common-law systems, can play an important role in the propagation of new scientific models into law and policy, even in the absence of concrete legislation and regulations doing so.³³ This part assesses the role of courts in protecting ecosystem services.³⁴

Even without invoking the term ‘ecosystem services’, courts have described specific types of ecosystem services as central to the development or application of legal doctrine. For example, the public trust doctrine, particularly in its American form, explicitly protects the benefits of ecosystem services such as fishing, water supply and navigation.³⁵ Recently, a Louisiana court identified protection of coastal areas from flooding as another benefit of public trust resources.³⁶ Courts in the United States have identified specific services in application of other common-law doctrines, such as a Rhode Island state court’s finding that depletion of the pollution filtration effects of a coastal pond would be a public nuisance,³⁷ and a New Jersey state court’s finding that the benefits of a public coastal dune system construction project must be taken into account when calculating the compensation due for the use of eminent domain to obtain the private lands.³⁸ These are important judicial pronouncements, but they are few and far between and do not expressly incorporate, and thereby advance, the ecosystem services framework.

An obvious question in response is, so what? As suggested by these decisions, courts could advance protection of ecosystem services without ever mentioning the term. They can point directly to flood control, groundwater recharge, and other benefits of nature. Why would it matter, then, if they adopt the term

³² JB Ruhl and James Salzman, ‘The Law and Policy Beginnings of Ecosystem Services’ (2007) 22(2) *Journal of Land Use & Environmental Law* 157.

³³ We use the terms ‘judges’, ‘judicial’, and ‘courts’ broadly to include all tribunals ranging from administrative law judges to municipal courts to the highest judicial court of the nation.

³⁴ This Part is based on a previous study in which one of the authors of this article, JB Ruhl, participated. See Ori Sharon et al, ‘Ecosystem Services and Judge-Made Law: A Review of Legal Cases in Common Law Countries’ (2018) 32(A) *Ecosystem Services* 9. Further background on that study, as well as updates and additional analysis of the results, is provided below.

³⁵ JB Ruhl and James Salzman, ‘Ecosystem Services and the Public Trust Doctrine’ (2006) 15(1) *Southeastern Environmental Law Journal* 223.

³⁶ *Avenal v State*, 886 So 2d 1085 (La 2004).

³⁷ *Palazzolo v State*, 2005 WL 1645974 (RI 2005).

³⁸ *Borough of Harvey Cedars v Karan*, 70 Atl 3d 524 (NJ 2013).

'ecosystem services' to explain the importance of those benefits? We believe there would be four important benefits. First, the framework provides the language and methodology through which those specific service benefits can be classified, compared and assessed. As courts adopt the framework, they could build a more coherent and comprehensive doctrinal approach to their protection. A case about sediment control from wetlands and another about storm surge protection from dunes seem different at first, but unifying them under the ecosystem services framework emphasises their similarities. Rather than developing wetlands protection doctrine and dunes protection doctrine in parallel channels, courts would be developing an overarching doctrine of ecosystem services. Second, courts command respect. If they start using the terminology and concepts of the ecosystem services framework, so too will parties, experts, lawyers and other judges. Third, judicial endorsement also supports adoption by legislatures and administrative agencies in legislative and regulatory text. Finally, purely as a practical matter, the term 'ecosystem services' is searchable, simplifying the task of finding cases that deal with these benefits of nature.

With all of those potential positive effects, one might expect the express language and concepts of the ecosystem services framework to have crept into judicial opinions through several sources. First, to the extent the framework is expressly embedded in legislation, regulations and policies, litigation involving those authorities would naturally lead courts to adopt the language of the framework. And even if those public authorities do not expressly adopt the ecosystem services framework, in litigation challenging the authorities government attorneys could use the framework as a basis for defending the authorities against claims of overreach. On the flip side, litigants might convince a court that the failure of those authorities to adopt the ecosystem services framework is somehow legally deficient. Also, a plaintiff might use the ecosystem services framework to articulate the injury needed to establish standing to pursue judicial remedies, even if the underlying merits of the litigation do not involve ecosystem services. Judges involved in public-law litigation could also adopt the ecosystem services framework on their own accord to frame and evaluate the dispute. Lastly, as suggested by the common-law doctrinal cases discussed above, parties or judges involved in tort and other common-law litigation could use the ecosystem services framework to describe injury, causation and other relevant features. In short, there are many ways judges could find themselves directly working with the ecosystem services framework in their opinions.

Alas, notwithstanding the many avenues through which courts could adopt and propagate the express formulations and language of the ecosystem services framework, by and large they have not. Using searches for 'ecosystem services' and related terms in legal databases, Sharon et al conducted a survey of case law from seven common-law nations and found that, as of August 2017, only 113 published opinions of judicial tribunals mentioned the concept of ecosystem

services.³⁹ Most of these opinions (67) fell into a category that Sharon et al described as ‘peripheral’, meaning that the ecosystem services concepts ‘are not central to the arguments or the decision made in the case — they serve to contextualize the central themes of the case or are one of many factors in the decision’.⁴⁰ Such cases are not unimportant, however. Although some of them involved a tribunal simply quoting passages from a regulation or pleading, many involved meaningful use of ecosystem services concepts to contextualise the litigation background and implications. Most of these (40) involved land development disputes, primarily in Canada but also from Australia.⁴¹ Other cases involved description of ecosystem services from water resources⁴² and general recognition of the benefits of ecosystem services to humans.⁴³

Sharon et al sorted the remaining 46 opinions — those going beyond peripheral use — into four categories: (1) cases from the United States involving use of ecosystem services concepts to establish legal standing; (2) cases involving interpretation of existing laws and regulations; (3) cases involving agency valuations of ecosystem services; and (4) cases from the United States involving agency use of ecosystem services to implement a regulatory program.⁴⁴ Australia, Canada and the United States accounted for the vast majority of these cases.⁴⁵ At least in those three nations, the ecosystem services framework is not a complete stranger to the courts, albeit the relationship is in its earliest of stages. Indeed, a case law update we conducted through Westlaw for those three nations and the United Kingdom revealed no new cases moving beyond peripheral use of the ‘ecosystem services’ term,⁴⁶ and we identified no published journal article since

³⁹ Sharon et al (n 35). The seven nations studied were Australia, Canada, India, Philippines, South Africa, the United Kingdom and the United States. For the methodology, see *ibid* 10–11. Sharon et al focused on common law nations given the prominent role courts play in forming and developing legal doctrine, including in the environmental policy domain (at 10). Only one other empirical study of the use of ecosystem services terminology by courts has been published: Roberto Pastén, Martin Olszynski and Michael Hantke-Domas, ‘Does Slow and Steady Win the Race? Ecosystem Services in Canadian and Chilean Environmental Law’ (2017) 29(B) *Ecosystem Services* 240.

⁴⁰ Sharon et al (n 35) 11.

⁴¹ *Ibid* 12, 18–19. For an example from Australia, see *Spencer v Commonwealth* (2015) 240 FCR 282.

⁴² For an example from Australia, see *Lee v Commonwealth* (2014) 220 FCR 300.

⁴³ For an example from Australia, see *Franklin v Valuer-General* [2013] QLC 10.

⁴⁴ Sharon et al (n 35), at 16–17, also discussed the connection between ecosystem services and the public trust doctrine, although they found no cases making that connection explicit.

⁴⁵ *Ibid* 13–16.

⁴⁶ We conducted a case law update through August 2020 using the Westlaw United States and Westlaw International databases, the latter of which covers Australia, Canada, and the United Kingdom among the nations Sharon et al. studied. All of the 13 judicial opinions found using the ‘ecosystem services’ terms during this period did so in ways Sharon et al categorised as peripheral—ie, quoting from party, expert, or other external materials and not addressing the concept in any other manner. There were four such cases from the United States: *Murray Energy Corp v EPA*, 936 F 3d 597 (DC Cir 2019); *Northern Plains Resource Council v US Army Corps of Engineers*, 2020 WL 1875455 (D Mont 2020); *United States v Brace*, 2019 WL 3778394 (WD Pa 2019); *Wilderness*

Sharon et al identifying use of the term by the courts of *any* nation.⁴⁷ While this does not amount to an exhaustive search of every nation's case law, the representative sample provided by Sharon et al and our update strongly point to the conclusion that courts have not meaningfully used the ecosystem services framework in substantive legal contexts.

What explains the dearth of judicial opinions adopting the ecosystem services framework? A partial answer is that if it does not show up in statutes, regulations and policies, litigation over those authorities is unlikely to fuel judicial uptake unless judges reach out to use it on their own accord, which they have done only sparingly.⁴⁸ The more statutes and regulations that invoke the ecosystem services framework, the more such cases we can expect to see. But that leaves several of the other avenues described above unaccounted for. Why have they not seen more action? We believe it is largely due to the failure of litigants to appreciate the advantages offered by framing their arguments for courts through the lens of ecosystem services. But it also is due in part to the need for scientific research on ecosystem services to connect with the nitty-gritty practical dimensions of litigation. Greater use of the ecosystem services framework by litigants could, however, help spark that kind of research. We explain what we mean with three example contexts: (1) standing to seek judicial relief; (2) common-law remedies; and (3) environmental impact assessments.

A *Standing*

Although all the common-law court systems that Sharon et al studied require some degree of specific personal interest — usually framed in terms of injury caused to that interest — for a litigant to establish standing to seek a remedy in the courts, only in the United States have court opinions dealt with a litigant alleging injury to ecosystem services as the basis for standing.⁴⁹ It is not clear

Workshop v US Bureau of Land Management, 342 F Supp 3d 1145 (D Colo 2018). There were three such cases from Australia. See *Parmac Investments Pty Ltd v Brisbane City Council* [2019] QPEC 32; *Walters v Brisbane City Council*, [2019] QPEC 3; *Gloucester Resources Ltd v Minister for Planning* [2019] NSWLEC 7. Canada and the United Kingdom accounted for the remaining six such cases. See, eg, *Peel Investments (North) Ltd v Secretary of State for Housing Communities and Local Government* [2019] EWHC 2143.

⁴⁷ We conducted our journal article search update through Westlaw, Science Direct, Google Scholar, and other journal databases.

⁴⁸ Sharon et al (n 35), at 14–17, review several cases in which the court addressed agency action under a statute or regulation that the agency defended through by expressly referencing ecosystem services. For an example from Australia, see *Abacus Funds Management v Sunshine Coast Regional Council* [2012] QPEC 46.

⁴⁹ Sharon et al (n 35) 13–14.

whether this is because that kind of standing claim is uncontroversial in other nations, or has simply never been advanced.

Once again, so what? Why should litigants in environmental and land use cases frame standing through the ecosystem services framework? For example, a litigant challenging a government permit approving filling of a wetland area could allege loss of groundwater recharge and increased pollution of an adjacent river. What would be the advantage of using the ecosystem services framework to articulate those injuries? To be sure, we are not suggesting that describing the specific services at stake is unnecessary. Rather, upon detailing the different injuries, invoking the ecosystem services framework can help demonstrate the interrelatedness of those seemingly discrete injuries, thereby emphasising the causal relationship between the challenged action and the alleged injury supporting standing.

Alleging injury to the benefits one receives from ecosystem services thus resonates with standing doctrine, but litigants must establish the factual predicates and not simply rely on broad claims. Two cases from the United States illustrate the point. In one, beekeeper and environmental organisations established standing to challenge federal pesticide approvals on the basis that they would suffer diminished ecosystem services provided by bees.⁵⁰ In another, however, a court rejected standing based on broad claims that allegedly inadequate wetland habitat offsets imposed in a land development permit would impair enjoyment of ecosystem services from an adjacent lake.⁵¹ Although several factors help explain the different outcomes, specificity of the claim that the challenged action would cause impairment of ecosystem services was one.⁵²

This illustrates the feedback between law and science that can be amplified when litigants begin using new scientific concepts, in this case to establish the requisite injury that entitles one to pursue judicial remedies. As litigants leverage scientific research on ecosystem services to establish standing, that demand can send signals into the research community regarding the scale and specificity of field research needed to support the claims. Researchers, for example, could develop methods for relatively fast and accurate measurements of service losses that litigants' experts could apply in the field. As such claims become more successful, litigants will use them more frequently, and so on. The key, of course, is for litigants to start generating that demand by using the ecosystem services framework to frame their alleged injuries.

⁵⁰ *Ellis v Bradley*, 2014 WL 1569271 *13 (ND Cal 2014).

⁵¹ *Public Employees for Environmental Responsibility v Schroer*, 2017 WL 943942 (ED Tenn 2017).

⁵² Sharon et al (n 17) 13–14.

B *Common Law*

Standing is a gateway into court, but the injury upon which it is based is not necessarily what is at the heart of the litigation. In the pesticide case discussed above, for example, once the injury to ecosystem services had been established, the litigation was largely over the government's process and rationale for approving the pesticide, not about compensating for the injury. By contrast, common-law tort claims are typically about compensating for the injury. Framing injury to ecosystem services as the basis for recovery in tort — eg as a private or public nuisance — thus presents an opportunity for law-science symbiosis even stronger than does the standing doctrine angle.⁵³

This will be particularly true when a plaintiff is seeking monetary damages. In the New Jersey state case mentioned above from the United States, in which the court found the filling of a coastal marsh would constitute a public nuisance, the outcome was that the court denied a property takings claim — ie denied the plaintiff just compensation for a land development permit denial. Imagine, however, a scenario in which the pond was filled and nearby landowners suffered loss of ecosystem services in the form of sediment and nutrient abatement and storm surge protection. Those injuries would surely be the basis for standing, but far beyond that the plaintiffs would need to cinch down causation and quantify actual losses in order to recover on the merits. Using the ecosystem services framework to do so would emphasise the causal connection, leverage the burgeoning ecosystem services research literature, and help guide future research at appropriate field-level scales.

C *Environmental Impact Assessment*

Environmental impact assessment prior to government approval of major actions has become a ubiquitous requirement across many nations. In the United States, for example, the National Environmental Policy Act ('NEPA') requires impact assessment for actions that federal agencies carry out, fund or authorise, which covers a lot of ground.⁵⁴ NEPA litigation often involves whether the action agency adequately included and analysed all relevant impacts. Following the pattern described above for standing and common-law actions, those impacts could include effects on discrete ecosystem services, such as the impacts approval of timber harvesting on federal land could have on carbon sequestration and

⁵³ JB Ruhl, 'Making Nuisance Ecological' (2008) 58(3) *Case Western Reserve Law Review* 753; JB Ruhl, 'Toward a Common Law of Ecosystem Services' (2005) 18 (Fall) *St Thomas Law Review* 1.

⁵⁴ 42 USC 4332 (2)(C)(i).

sediment into waterbodies. NEPA is a broad lens and there is little debate that an agency could use the ecosystem services framework as a way of organising and analysing such effects.⁵⁵ Again, why do so?

Whereas the use of the ecosystem services framework in the standing and common-law tort contexts is primarily to improve understanding of causation and degree of injury, NEPA is not a remedial statute. Its central purpose is to improve agency decision-making and communication. We see incorporating the ecosystem services framework into such environmental impact assessment programs as producing several potential advantages. First, if used across the array of agencies conducting assessments, the ecosystem services framework will provide a common language, making assessments more accessible to stakeholders. Doing so will also allow easier and more direct comparison between assessments. Most significantly, however, is that unifying effects under the ecosystem services umbrella demonstrates their interrelatedness and thus allows better trade-off analysis.

To be sure, there are potential downsides to this approach, not the least of which is that new methods and scientific research will be needed.⁵⁶ This partially explains why federal agencies in the United States have not widely adopted the ecosystem services framework in their NEPA analyses.⁵⁷ To disrupt that inertia, litigants could challenge agency assessments for lack of adequate integration of the ecosystem services framework, arguing that treating the suite of services in an unbundled form understates overall effects and obscures trade-off analysis. Granted, that would be an uphill climb, as courts are reluctant to impose methodology on agencies. In one case from the United States, for example, a court refused to require an agency to quantify in monetary terms all lost ecosystem service benefits in its NEPA analysis of a timber harvesting permit, concluding nothing in existing law or regulation mandated such an approach.⁵⁸ But efforts to force agencies to consider impacts on climate in NEPA analyses faced a similar battle before the courts eventually mandated such analyses.⁵⁹ Indeed, Australia offers an example of litigants successfully challenging an agency permit approval for lack of adequate attention to ecosystem services impacts in the required economic impact assessment, leading to revocation of permits to expand a coal-mining operation.⁶⁰

⁵⁵ Robert L Fischman, 'The EPA's NEPA Duties and Ecosystem Services' (2001) 20(2) *Stanford Environmental Law Journal* 497.

⁵⁶ Carrie Presnall, Laura López-Hoffman and Marc L Miller, 'Adding Ecosystem Services to Environmental Impact Analyses: More Sequins on a "Bloated Elvis" or Rockin' Idea' (2015) 115 *Ecological Economics* 29.

⁵⁷ *Ibid.*

⁵⁸ *Clinch Coalition v Damon*, 316 F Supp 2d 364, 380 (2004).

⁵⁹ David Markell and JB Ruhl, 'An Empirical Assessment of Climate Change in the Courts: A New Jurisprudence or Business as Usual?' (2012) 64(1) *Florida Law Review* 15, 57–65.

⁶⁰ *Bulga Milbodale Progress Association Inc v Minister for Planning and Infrastructure* [2013] NSWLEC 48.

IV PROTECTION OF COASTAL MANGROVE ECOSYSTEM SERVICES

We have now provided a tour of how policy instruments and courts have protected ecosystem services in a number of nations around the world. Going from the global to the local, what lessons can these experiences tell us about strategies to protect coastal mangrove ecosystem services in Australia?

For Australian mangroves in Queensland, Associate Professor Justine Bell-James has concluded that the law

is not structured in a manner that ensures protection for these ecosystems ... The Queensland legal regime appears to offer reasonably high recognition of mangrove ecosystem functions, but does not take the final step of fully acknowledging and protecting ecosystem services.⁶¹

So how can this be improved?

The starting point is the importance of politics. We find strong protection for ecosystem service protections where there is a strong political mandate. Political support is necessary for the simple reason that all of the Five P's rely on government initiative. Given all the different interests pushing for governmental intervention, mangrove protection needs to rise near the top. Often (indeed, usually) this is at a local rather than national level, reflecting public concern. This can come about when there are high property values. Owners who wish to maintain protection of their houses from floods will often support policies that keep mangroves (and their storm protection services) in place. More generally, support for protection of services can be expected to increase when there is (1) a perceived connection between ecosystem degradation and loss to human communities, and (2) a clear, credible threat to the ecosystem. Both of these depend on the importance of perceived scarcity.

Indeed, as a general matter, the most effective ecosystem conservation (by both state and non-state actors) is driven from perceived scarcity of an ecosystem service and the resulting threat of harm. Nor is this surprising. When government restricts development or makes it more expensive, it needs a political justification for the pushback that will inevitably follow. Mangroves provide key ecosystem services of protection against storm surges, flood protection and wildlife habitat, among others. When the perceived harm from depleted wetlands is significant, political and private actors are more likely to mobilise to conserve their ecosystem services. As a result, we believe that as a general proposition: *effective policies or court decisions protecting mangroves require a clear connection between mangrove conservation and the benefits provided by mangrove services.*

⁶¹ Bell-James (n 10).

This places science and communication squarely in the picture. Demonstrating the opportunity cost of not conserving mangroves requires scientific and economic research. A factual case highlighting the economic importance of mangrove service provision will almost always be the precursor to laws and court decisions protecting mangroves. One strategy is to map where the mangroves are located and where their benefits flow. This identifies which beneficiaries would be harmed, and by how much, if the service flows are reduced. Mapping of ecosystem services thus has become a dominant theme in scientific research,⁶² but more work is needed to translate that knowledge over to policy domains to influence political support.

Once there is political support to protect mangroves, then the Five P's and courts can come into play, articulating the costs and benefits of different conservation strategies to legislatures, agencies and courts. Does existing law provide the authority to promote the ecosystem services framework? To answer this, lawyers must identify gaps, exceptions and other potential impediments.⁶³ Working with scientists and economists, they must articulate the relevant benefits and harms to legislatures, agencies and courts in the ecosystem services framework.

V CONCLUSION

We well realise that incorporating ecosystem services protections into the law, and then ensuring implementation, is far easier said than done. Our three key words of advice, therefore, are: 'Do Not Despair.'

Policy-uptake takes time. Where we have seen the ecosystem services framework penetrate policy and court opinions, the tide shifted slowly. Carbon sequestration, which today dominates discussion of ecosystem services, was not in the climate change policy mix/ecosystem services discussion three decades ago. Wetlands, once deemed a nuisance by the US Supreme Court, were not statutorily protected in the United States until the 1980s and were not recognised in the agency rules as sources of ecosystem services until 2008.⁶⁴ The US Forest Service did not recognise national forests in the agency's rules as sources of

⁶² Francesc Baró et al, 'Mapping Ecosystem Service Capacity, Flow and Demand for Landscape and Urban Planning: A Case Study in the Barcelona Metropolitan Region' (2016) 57 *Land Use Policy* 405; Jeannette Sieber and Manon Pons, 'Assessment of Urban Ecosystem Services Using Ecosystem Services Reviews and GIS-Based Tools' (2015) 115 *Procedia Engineering* 53.

⁶³ For an example, see JB Ruhl, 'Ecosystem Services and the Clean Water Act: Strategies for Fitting New Science into Old Law' (2010) 40(4) *Environmental Law* 1381.

⁶⁴ For this history, see JB Ruhl, James Salzman and Iris Goodman, 'Implementing the New Ecosystem Services Mandate of the Section 404 Compensatory Mitigation Program — A Catalyst for Advancing Science and Policy' (2009) 38(2) *Stetson Law Review* 251.

ecosystem services, particularly those beyond provisioning and cultural services such as timber and recreation, until 2012.⁶⁵ Coastal dunes, once flattened to make way for development and views, are being reconstructed in recognition of their ecosystem services through the massive project along the New Jersey shore mentioned above.

The necessary work to promote law and policy to conserve mangrove ecosystem services in Australia is underway. This article has set out a pathway for greater appreciation and protection of their valuable ecosystem services.

⁶⁵ For this history, see JB Ruhl and James Salzman, 'Ecosystem Services and Federal Public Lands: A Quiet Revolution in Natural Resources Management' (2020) 91(2) *University of Colorado Law Review* 677.

